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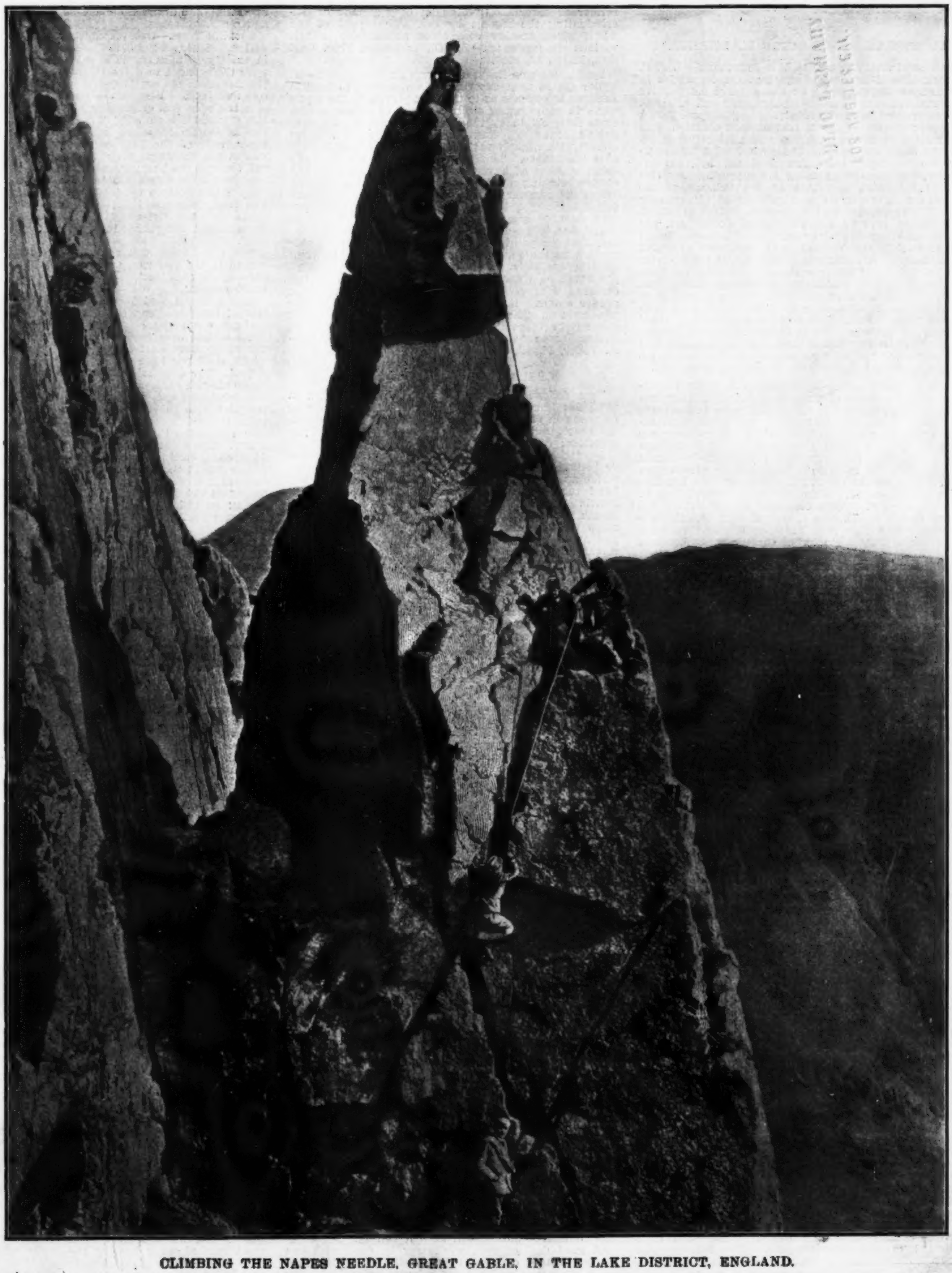


CLIMBING THE NAPES NEEDLE, GREAT GABLE, IN THE LAKE DISTRICT, ENGLAND.

MOUNTAINEERING IN ENGLAND.

The Alps have so exclusively demanded the attention of the mountaineering tourist that little if anything is known of the hilly regions of other parts of Europe, regions which present dangers fully as great as those of the huge mountains of Switzerland. In the Lake district in England, for example, some of these dangers were tragically emphasized by the sad death of several persons, among them Mr. O. G. Jones, the well-known mountaineer. Our illustration shows the Great Gable, one of the peaks which a traveler passes on the way from Keswick to the Scawfell. In the picture the late Mr. O. G. Jones is seen on the top. The mountains in the background are the Scawfell range, the scene of the recent accident in which Mr. Jones lost his life. The Napes Needle is on the southwestern face of the Great Gable, facing Wastwater, and is one of the toughest bits in the whole district. In winter the ascent has proved too much for even the strongest climbing parties. Our illustration is taken from the London Graphic.

CONTEMPORARY ELECTRICAL SCIENCE.*

Specific Ionization by Radium Electrons.—J. J. E. Durack showed some time ago that the corpuscles in the Lenard stream make on the average 0.4 positive and negative ions in traveling through 1 cm. of air at a pressure of 1 mm. of mercury. If we suppose that a corpuscle creates a pair of ions at each collision with the molecules, these corpuscles make 0.4 collision under the same conditions. The author calls this number the "specific" ionization produced by the corpuscles, and mentions reasons for supposing that this specific ionization decreases as the velocity of the corpuscles increases. For a velocity of 10^9 cm. per second, Townsend found a specific ionization of 20. The Lenard rays have a velocity of 4×10^9 cm. per second, and therefore give a smaller ionization. A still higher velocity is furnished by the electrons projected from radium. According to Kaufmann, it ranges from 2.36 to 2.83×10^{10} cm. per second. The author finds that their specific ionization is correspondingly less, being 0.17 on the average. This implies a very large mean free path, amounting to 6 cm. in air at a pressure of 1 mm. in air. This large mean free path would account for the smallness of the absorption undergone by the corpuscles. There is no reason to doubt that the corpuscles are simply electrons having the standard charge.—J. J. E. Durack, Phil. Mag., May, 1903.

Optical Resonance.—According to A. Bock, the diameter of the drops of water in a steam jet increases from 0.0034 millimeter to 0.0046 millimeter in the space extending from the point where the steam first becomes visible to the point where the vapor disappears from view. If a brilliant point is looked at through the steam, it is seen surrounded by brightly colored rings. These rings may be enlarged by blowing an acid vapor into the steam jet. Its color then becomes more blue than red. When the jet is colored blue in this manner and is then examined by red light it becomes invisible. This is a case of pure selective absorption. The blue rays are absorbed and radiated when the average diameter of the molecules becomes equal to the wave-length of the light employed. Each droplet then becomes an optical resonator, absorbing and giving out the light of the wave-length corresponding to its own size. These rays are not polarized. Polarized rays are reflected from larger drops when illuminated with strong plane-polarized light. The author supposes that the blue of the sky is due to optical resonance, and points out that the study of the polarization of light reflected from the planets may furnish some indications concerning their structure. —A. Bock, Physikal. Zeitschr., April 15, 1903.

Influence of Radium Rays on Generation.—G. Bohn has continued his researches on the biological action of radium rays, and has experimented on over 8,000 ova of the hedgehog, Strongylocentrotus lividus. While most of the phenomena of development are arrested, there is an acceleration at certain stages. A somewhat startling result is that while the spermatozoa are killed by the radiation, some 3 per cent of the unfertilized ova show signs of parthenogenetic development under the influence of radium rays. The difference of the two effects seems to be somehow connected with the fact that the spermatozoa consist of unprotected chromatine, whereas the chromatine of the virgin ova is protected by protoplasm. It appears, as a general rule, that the rays have more effect upon tissues in the course of formation than upon more stable tissues. In man, the skin, which is in constant process of renewal, is more attacked by the rays than muscle. An exception to this rule is, however, apparent in the case of nerve cells, which are affected by the rays although fully formed. The exception may be due to a peculiar sensitiveness in the structure of nerve matter.—G. Bohn, Comptes Rendus, May 4, 1903.

New Self-Restoring Coherer.—Sir Oliver Lodge describes a new automatic coherer in the form of a rotating sharp-edged steel wheel, about ½ inch in diameter, constantly touching a pool or column of mercury on which is a thin layer of oil. No effective contact occurs between the wheel and the mercury, notwithstanding the immersion, because of the film of oil; but the slightest difference of potential applied to the two, even less than 1 volt, is sufficient to break the film down and complete a circuit, which, however, the rotation of the wheel instantaneously breaks again. The spark is so sudden that for its purposes the wheel is for the instant virtually stationary, and yet the decohesion is so rapid that signals can be received in very rapid succession. The definiteness of the surfaces and of the intervening layer make the instrument remarkably trustworthy, and the thinness of the insulating film makes it very sensitive. In fact, a single cell of a battery cannot be employed as a detector, because it is of too high a voltage for the film to stand. A fraction of 1 volt is employed by a potentiometer device—usually something like 1-10 volt—and it is adjusted to suit circumstances. The battery acts through the coherer direct on a low-resistance recorder, and the record on the strip shows every character of the arriving pulses, and exhibits any defect in the signaling. Provided that every joint and contact, except the one intended to be filmed, is thoroughly good, the coherer in this form is so definite and satisfactory that it becomes safe to say that the only outstanding defects are those which occur at the sending end. The signals are picked up and recorded precisely as they are emitted, as has been tested by intercalating a siphon recorder in a much-diluted tapping circuit at the sending end, so as to get a record with which to make comparison. The traces obtained at the two ends are identical to a surprising degree. The mercury level has an adjustment which is easily made. One precaution is to keep the rim of the wheel clear of dust, which is done by a cork or leather pad pressed lightly against it by a spring. The instrument is not at all sensitive to tremor, and requires no particular delicacy of adjustment. The wheel has to be positive, the mercury negative. A telephone in circuit, through a transformer or otherwise, affords an easy method of discriminating the signals by ear. The speed of the wheel gives another convenient adjustment to suit various circumstances.—Sir Oliver Lodge, Proc. Roy. Soc., March 12, 1903.

Propagation of Electric Waves by the Earth.—A. Voller quotes some experiments which tend to confirm Lecher's hypothesis as to the part played by the whole earth in propagating electric waves to points hidden from their origin by the earth's curvature. He used Seibt's apparatus, consisting of a closed condenser circuit with slightly variable capacity but largely variable inductance. This apparatus, in which the indicator consists of a vacuum tube, was specially valuable in bringing out the value of earthing the receiver. When the receiver was insulated, the range of signaling did not exceed 3 feet. On earthing it, the range was extented some ten or twenty times. This was found not to be due to better resonance, but to the fact that the point which is opposite the antenna connection in the sending circuit is the focus of strong electric oscillations, which are transmitted through the earth on earthing it, and are caught up by the earthing wire of the receiver. The earthing of the sender antenna itself does not give rise to the same phenomenon. The author thinks it quite possible that the energy transmitted through the earth does not decrease even in a linear ratio with the distance.—A. Voller, Physikal. Zeitschr., April 15, 1903.

* Compiled by E. E. Fournier d'Albe in the Electrician.

OPERATION OF GAS RANGES.

The following notes have been taken from a pamphlet issued to consumers by the Public Service Corporation of New Jersey, and embrace many practical considerations of value to gas inspectors and instructors:

Burners.—Do not light a burner until the cooking or boiling is ready to begin. To light these burners strike a match, hold it at arm's length; with the other hand turn on the valve and at once apply lighted match. The suggestion of holding the match at arm's length at the moment the burner valve is opened is to allow sufficient time for the gas to reach the burner and avoid what is known as "snapping back," which might occur if the match is applied to the burner at the moment the gas is turned on, the consequence being a disagreeable smell and unsatisfactory results.

When boiling, the top burners should be lighted and turned on full head until boiling begins. The gas should then be partly turned down, as a reduced flame will readily maintain the boiling temperature. When slow cooking is desired one of the small burners may be used, and the flame turned low after simmering has begun.

The oven burners are ignited generally with a "pilot light," otherwise the same rule should apply as in the case of the top burners.

Ovens.—Broiling and toasting. This, with a double oven range, is best done in the lower oven under the flame. Light the oven burners ten minutes in advance, with the lower oven door closed. An ordinary gridiron should be used, and placed on the broiling rack as close to the flame as possible without contact, leaving the lower door open during the operation. For very thin steaks or English chops care must be used, else the surface will cook too quickly. In such cases the flame should be turned down or the broiling rack placed lower as soon as the surface of the meat begins to brown.

Roasting. In an ideal way this should be done as broiling, but it requires considerable attention on the part of the cook. From the practical standpoint, roasting is best done in the upper oven. If it is a rib roast of beef, of from 6 to 10 pounds, heat an ordinary baking pan sizzling hot on the top burners. In this quickly brown both sides of the roast and place in the upper oven on the lower slide, as in a coal range, the oven burners having been lighted for 10 minutes. Care should be taken to reduce the heat in proportion to the size of the roast. While the meat is roasting in the upper, potatoes can be baked to perfection in the lower oven.

Baking. Heat the baking oven 10 minutes, then reduce the flame as the heat of the oven may require to bake different articles, giving them a shorter time than is required in a coal stove.

Bread should be placed in a very hot oven. When the loaves begin to brown, turn out one burner or reduce the flames of both. About five minutes before the bread is done turn out both burners—there will be heat enough left to finish the baking.

Biscuits and pastry require a very hot oven. Biscuits should bake about 12 minutes.

Operation.—Every day wash the top burners and drip pan, and rub with an oily cloth. Once a week wash the ovens and rub them with an oily cloth.

Be thoughtful. Do not light burners too soon; turn them as low as practicable. Extinguish them as soon as the work is done.

Do not use a large burner where a small one will do the work. When a kettle reaches the boiling point the simmering burner will keep it boiling.

A good deal of oven work may be done with one burner instead of two. Some baking can be finished with burners turned out five minutes before.

Time Lost in Cooking.—The average housewife, on being told that fully one-quarter of her time is taken up in cooking her meals, would be inclined to resent the remark as a reflection on her culinary ability. Yet the same is as true as gospel, provided the wife in question is following the methods still in vogue in many households of preparing the day's meals on an ordinary coal stove or range.

If she sums up the time wasted for an entire year, allowing three meals a day, she will be confronted with the startling news that fully 15 days reckoned in periods of 15 minutes for each meal have been lost. These statistics are the results of tests on first class coal or gas ranges.

The time taken from lighting a fire in a coal stove until the meal was placed on the table was exactly 2 hours and 50 minutes. The time for a gas stove was exactly 2 hours. Further comparison showed that the housewife using the coal range had the additional labor of inspecting the fire every 15 minutes, turning the roast at least three times an hour, altering and regulating her drafts innumerable times, carrying coal and removing ashes.

Cooking Tests.—Gas. A constant, steady blue flame without flicker, brought the water to the boiling point in exactly 10 minutes on a gas range; the vegetables were then placed in a vessel and the lids secured. In the meantime the oven burners were generating a positive and intense heat in the oven; within a few minutes the oven was sufficiently hot to receive the roast. From that time on until it was carried to the table the housewife inspected and basted the roast four times, reduced the heat in the oven just once, that was in the beginning after the meat had received the full force of the heat; the albumen on the surface was hardened by the first process to a proper degree, and the juices therefore retained in the body of the meat. The coal range could not have done this except in a crude and unsatisfactory way. The control of the flame means everything in successfully preparing the meal.

When the roast was removed, the loss in the one cooked in the coal range was exactly 2 pounds and 11 ounces; the roast cooked by the gas range lost 1 pound and 9 ounces.

A test for all food for the meal showed the average loss of nutritive properties in those cooked over the coal range was 30 per cent, exactly twice the amount of those cooked over the gas range. The figures of the gas range were as follows: Gas consumed, 38 feet, which at $1 per 1,000 cubic feet, cost 3.8 cents.

Coal. The first half of the 2 hours and 50 minutes required with coal was taken up in heating the oven. The wind was not just right and the wind played the mischief with the dampers; when the meat began to roast the cook's fears were that she had too quick a fire; regulating the drafts and dampers was the next worry. The amount of coal used for this dinner was 44 pounds, costing exactly 11.75 cents at the rate of $6 per gross ton, the total saving of gas over coal being 7.94 cents or 47.8 per cent. If the above represents a saving on one dinner, what, to your mind, would be the saving on 365 dinners, as well as 365 suppers, and the same number of breakfasts prepared in the course of a year?

A comparison of percentage in loss after cooking was lately made by a well-known gas expert. This is his report:

Fish costing 35 cents showed a loss over the gas range of 6.5 cents, and over the coal range, 10.25 cents; the difference in saving in favor of the gas range was 3.75 cents.

Chicken costing 61.25 cents showed a difference of 8.75 cents in favor of the gas range; steak, 2.625 cents; chops, 3.125 cents, and beef, 24.75 cents.

The total saving in the cost of food cooked on the gas range over that cooked on the coal range was 43.6875 cents. Add to this the saving 7.94 cents in product as before mentioned, and the total reaches 51.70 cents—a most magnificent saving when compared with the total cost yearly of food and fuel in the average household.

Saving by Gas.—A gas range is, in a measure, misnamed, because the proportion of gas to that of air consumed is as one to three. Compared with an ordinary illuminating jet the consumption is one to eight, or in other words, eight holes in a gas range burner consume but the same amount of gas as an ordinary jet on the wall bracket or chandelier.

This is the expense. The saving is a ton of coal monthly, a load of kindling wood consumed in a comparatively short time, the cost of removing ashes from the cellar, the renewal of the fire brick, and the vain and hopeless effort to secure perfect combustion in an obsolete coal range.

Advantages.—A gas range will broil steak to a delicious brown, leaving the inside a rich and luscious red, and retaining all the albumen and nutriment.

Another advantage of the gas range is that it can be used for toasting bread and biscuit for the sick room at any hour of the day or night.

Baking in a gas range is always a delight to the ambitious housewife. With the double ovens she feels the work in no way interferes with the preparation of the regular meal.

Hot Water Heating.—Many people who have been paying for gas used for illuminating purposes are somewhat dubious about using gas for fuel on account of the supposed high cost. While it is true that the units of heat contained in coal—the price of coal being normal—are many times cheaper than the same number of units of heat contained in gas, yet, under many conditions, gas is the cheaper fuel. When it is necessary to apply the heat in a large way and for a long time, as for instance, under a steam boiler, of course coal is much cheaper; but where the heat is only wanted intermittently and but for a short time and in a small way, gas at any ordinary price will prove the cheaper.

In burning coal for domestic purposes it is estimated that nine-tenths of it is wasted, i. e., goes up the chimney, heats up the range and the tile in the range, heats up the kitchen, and to some extent, the entire house. The waste of fuel when heating with coal is most marked when heating the water with an ordinary water-back and kitchen boiler. The water-back and boiler came into general use about 30 years ago.

Since that time there has been no improvement to speak of in this plan of heating water.

The storage boiler is a wasteful device, as quantities of coal are consumed to heat the water it contains, when the chances are that this water will have cooled off before it is wanted. With any storage system of water heating, this alternate heating and cooling keeps up day and night, so that every gallon of hot water used has been heated and re-heated some half-dozen times, becoming stale and flat, totally unfit for the bath.

It is easy to see why such a crude system of heating water as this would be more expensive, even with cheap coal, as compared with gas, than a system by which the water is not heated until needed, and then only as much heated as used.

Hot water is just as essential as cooked food. When gas ranges were first introduced, it was with difficulty that the housekeeper could be persuaded to give up the coal range, even for a trial. Would it do the work? How about the gas bill? Was it perfectly safe? To all of these questions the enormous number of gas ranges now sold every year is the best answer and conclusive evidence that the gas range has come to stay, and when once used is never discarded.

With the gas range established, the hot water problem arose. Gas water heaters have now passed through the experimental stage to a success equal to the gas range, and no one who cooks with gas can afford to be without a gas water heater. Dishes must be washed with hot water, warm baths are necessary, and, in case of sickness, hot water is often a saver of life—always a necessity.—Progressive Age.

ELECTRIC AUTOMOBILES.*

At the present time there are, in London alone, upward of 16,000 licensed horse carriages, apart from private vehicles, tradesmen's vans, etc. It is estimated that more than 200,000 horses are stabled each night in London, necessitating the daily removal of at least 5,000 tons of manure and refuse, in addition to what is distributed over the roads. The daily growth of London and of other large cities renders the problem of substituting motor-cars for horse traction, even from a sanitary point of view alone, of the first importance. Electric automobiles have now become thoroughly practical vehicles, single journeys of more than 100 miles on one charge and tours of more than 1,000 miles having been accomplished satisfactorily. Electrical energy is an economical and readily-applied form of power, which is noiseless in its application, gives rise to neither smell nor refuse, and possesses the advantage that it can be turned on and off at will. It is only since the passing of the Locomotives on Highways Act, 1896, that the problem of motor-cars has been seriously attacked in England, and this country is far behind France, America, and Germany, where no such restrictions had to be fought against such as hampered their development here before 1896. In America, electric carriages were being made in 1894. It is interesting to note that at that time the limit of a run on one charge was 20 miles. Germany, France, Austria, America, Italy, Spain, Belgium, and other countries are giving earnest attention to the manufacture and improvement of electric vehicles, and in most of these countries makers are assisted directly by government subsidies, by official trials, as in Berlin, and otherwise. In England it has been left to private enterprise to compete with the foreigner for a share in this new and important industry, which even now gives employment to about 10,000 men in this country. The weight of the earlier electric carriages was out of all proportion to the weight of the batteries carried by them, due to the attempt to utilize existing coach-builders' work strengthened to carry the batteries. Further, the batteries and motors were very inefficient. In the electric cabs used in London a year or two ago, the total weight of the vehicle, battery, motor, and gear, for carrying a useful load of 4 hundredweight (passengers and driver), was over 2 tons, a ratio of 1 : 10. These vehicles may be contrasted with a bicycle, weighing only 26 pounds and carrying 140 pounds, or five times its own weight. In the electric cabs the weight on each wheel was about 10 hundredweight; in a bicycle the weight on each wheel is about ¾ hundredweight.

Dealing with storage batteries, the author stated that the active agents of the storage batteries in general use are lead and dilute sulphuric acid. The batteries may be divided broadly into two classes, namely, the "to-be-formed," or Plante kind (1873); and the "pasted," or formed Faure type (1881). The object of both these processes is to produce a couple consisting of a positive electrode of lead oxide, and a negative electrode of lead in a solution of sulphuric acid and water. Peroxide of lead is formed on the positive, and pure lead on the negative, by the process of charging; and energy is stored which is given up on discharging the battery, the electrodes returning to their first state of lead sulphate. The pasted cell is lighter than the other, and is more generally used in electric automobiles. The improvements made in storage-batteries to adapt them to electric automobiles are mostly in mechanical details of the supporting grids, to allow full expansion of the paste and to avoid sulphating; in the increase of the specific gravity of the electrolyte, from between 1.05 and 1.20 to between 1.15 and 1.30, and the consequent decrease in volume and weight and increased output in the chemical composition of the active material, i. e., paste; and in the mixture of the paste with inert materials to make it more coherent and porous. As a result, batteries for traction now give, weight for weight, three or four times the output of batteries used for electric lighting. A zinc and peroxide-of-lead battery of 120 ampere-hours can be charged at 90 amperes for 2 hours, and discharged at 20 amperes to 100 amperes. The output of the various storage batteries, as given by the manufacturers, is shown in table A.

Some very careful tests to determine the durability of storage batteries were made by the Automobile Club of France in 1899, extending over six months. The tests were made under conditions analogous to those that would obtain in the carriages in actual use. The sets of batteries were equally charged at a 24-ampere rate to 2.5 volts per cell, but were discharged at rates varying between 20 amperes and 100 amperes, with intermediate periods of rest; and while being discharged they were subjected to artificial vibration, to give the effect of the vibration occurring on roads, this treatment being continued until the cells showed signs of failure. The results were as given in table B. Recent tests of storage batteries in America and in England have shown much better results, and in France 3,000 ton-miles is at present obtained with a loss of efficiency of about 10 per cent. Storage batteries for electric automobiles can be obtained which will give 1 horse power hour for 67.2 pounds weight of complete cells, with a durability of 3,000 ton-miles, allowing 10 per cent loss of efficiency and an efficiency of charge and discharge of 80 per cent. This means that an electric vehicle, weighing, say, 6 hundredweight, with a battery weighing 6 hundredweight, and a load of the same amount, could run 10 miles per day for 330 days in the year, i. e., 3,000 ton-miles, taking 100 watts per ton-mile, at a loss of efficiency in the battery of 10 per cent.

TABLE A.

	Watt-hours per Lb. Complete Cell.	E. M. F. of Discharge.
		Volts.
Faure-Sellon-Volckmar (France)	9.0	2.0
Fulmen (France)	11.0	2.0
B. G. S. Modified Fulmen (France)	12.65	2.0
E. P. S. Faure-King (England)	8.0	2.0
Rosenthal "National" cell (England)	15.0	2.0
Lee-coil. (Lead and zinc with cadmium) (England)	10.6	2.5

TABLE B.—TESTS OF BATTERIES MADE BY THE AUTOMOBILE CLUB OF FRANCE, 1899.

Name.	Weight. Lbs.	Total Number of Discharges.	Total Kilo-watt-Hours.	Ton Miles at 100 Watt-Hours per Ton-Mile.	Efficiency fell from	Total Kilo-watt-Hours per Lb. of Cell.
					Per cent.	
Tudor	236.5	135	135.8	1,358	67 to 60	0.57
Biot Fulmen	215.6	132	143.9	1,439	76 " 68	0.67
Fulmen	148.5	98	101.9	1,019	77 " 66	0.67
Phoenix	202.4	102	118.8	1,188	75 " 66	0.5
Pope	220.0	135	155.6	1,565	74 " 70	0.7

The motors designed specially for electric automobiles are of light weight compared with electric motors used for driving stationary machinery; they are of high efficiency, are capable of bearing very rough usage, and an overload of 100 per cent for short periods. The author then briefly described the Still, the bipolar single-coil Lundell motor, the Krieger motor and gear, and the motor designed by himself. The latter has eight poles with the armatures revolving outside the fields. The armature has a long sleeve-bearing with a sprocket-pinion at its end, and by means of a chain drives the large sprocket-wheel attached to the spokes of the carriage wheels. This motor is very light, weighing 112 pounds, and giving 2 boiler horse power at 700 revolutions per minute. It runs sparklessly, and owing to the large surface of wire exposed on the armature it will stand an overload of 100 per cent, while it has an efficiency varying between 80 per cent and 90 per cent, according to the load.

Many ingenious methods of controlling electric automobiles in regard to direction of travel, speed, braking, recuperation, and recharging, have been devised. The controller is simply a commutating switch, or circuit-changer, and the system in general use is an adaptation of the series-parallel controller used on electric railways and tram-cars, and consists in grouping the batteries in parallel or in series as change of speed is required, or grouping the motors in parallel or in series with the same object, and also in combining the two. The author then described the system used by Jeantaud, Krieger, Northey, and others.

After dealing with underframes, the author went on to describe the size of wheels, which is a question which has recently received special attention. Dr. Luxenberg has shown that for level roads the resistance to traction, and the energy consumed, are, within certain limits, inversely proportional to the diameter of the wheels of the car; and he advises the use of wheels between 3 feet 3 inches and 5 feet, or more, in diameter. He estimates that the use of these larger wheels in place of the 2-foot 6-inch or 3-foot wheels generally used would effect a saving on the level of about 40 per cent. This, however, would not apply to hill climbing, where the power must be increased almost in proportion to the gradient, necessitating either a lower speed or a large reserve of battery power. Wheels over 3 feet in diameter present difficulties in respect of reduction of speed. It is obvious that wheels of such diameter bridge the ruts and depressions of a bad road much more than 2-foot wheels, and with the heavy weight of electric cars the sinking and re-lifting of the car means great loss of power. As regards air-resistance, assuming that this follows Smeaton's rule, and also that, for purposes of calculation, the irregularities of the surface of a road may be allowed for by regarding the cross-sectional area of the car as forming half the curved surface of a cylinder, the pressure becomes serious at above 12 miles per hour, and has to be taken into account in determining the power required. The electric motor can be made with as high an efficiency as 85 per cent, and the loss in the gearing, especially high-class chain-gear, is about 2½ per cent. Allowing 25 per cent for all losses, including the friction of the carriage wheels, 75 per cent is a fair all-round efficiency, and well within the conditions of practice.

Electric automobiles, when properly designed, possess the unique feature that they can return energy to the batteries when running down hill, the momentum of the vehicle causing the motor to act as a generator, while at the same time forming a very convenient automatic brake. At the Chiselhurst trials in November, 1900, the highest current recorded for car No. 3 when ascending the steepest hill (gradient 1 in 10) was 119 amperes, and in descending the same hill a back charge of 35 amperes was given to the battery. The total weight of the car, with passengers, was 19 hundredweight. In many long runs on electric automobiles the author stated that he had not used the mechanical brake at all, stopping and reducing speed solely by the reactive effect of the motor. This makes the control of an electric motor-car simpler than that of any other self-propelled vehicle, and, of course, there is no loss of energy with shunt-wound motors in stopping, but rather a gain.

The ratio of the weight of the vehicle to the weight of the power-giving battery is of great importance. Generally, as the ratio of the weight of the battery to the weight of the vehicle increases, the distance that such a vehicle can be run on one charge is increased; but of greater importance from a practical point of view is the load-carrying capacity, and the ratio of the weight of the useful load to the weight of the battery and vehicle. The author submits that cars in which the weights of batteries, vehicle, and load are equal, are, all things considered, the most suitable for electrically-propelled vehicles.

The last point for consideration is the cost of electric propulsion on common roads, and in order to put this question in a clear form, the author prepared a table giving the comparative costs of different motor-cars. It is possible to run electric vehicles on a good level road with an expenditure of only 50 watt-hours per ton-mile, at a cost for electric energy of 0.1d., taking the actual cost of generating the electricity, with a fair profit, at 1½d. per Board of Trade unit. This cost will compare favorably with any other system of self-propelled carriages, and makes electric propulsion on roads, with its advantages already enumerated, more promising than any other system of motor-carriages. The difficulty of obtaining a fresh charge for the batteries is now being rapidly overcome, owing to the readiness of the electric-supply companies in towns and in country districts to provide motor-houses, and to recharge at all hours of the day and night, at a reasonable cost. Charging can be effected in every district in London, and at Chelsea, Hampstead, Richmond, Windsor, Watford, Stratford, Leyton, Harrow, Chiselhurst, Putney, all on main roads leading from London; farther out there are charging-stations at Guildford, Crawley, Woking, Tonbridge, Chelmsford, Luton, Cheltenham, Reading, Maidenhead, and other towns on the River Thames; and still farther afield the like facilities are afforded at Brighton, Southsea, Hastings, Oxford, Bath, Bedford, etc., and many other towns throughout the country. It appears to be desirable to fix upon a standard for the electro-motive force to be used in electric automobiles; such a standard would be of great advantage to the designer and manufacturer of such automobiles, and of the motors, batteries, etc., used in them. The potentialities of electric propulsion of carriages on common roads are very great. France, America, Germany, and other countries are far ahead of England in regard to the manufacture of motor cars; but the author hopes that England will now take its place in the world with this new industry, as she did in the past with the steam locomotive.

* Abstract of paper read by Mr. H. F. Joel, Assoc. M. Inst. C.E., before the Institution of Civil Engineers, January 13, 1903.

DESTRUCTION OF INSECTS—A NEW USE FOR ELECTRICITY.

Some time ago the German press had much to say concerning the efforts being made by a certain electrical engineer of Munich, Mr. Hugo Helberger, to clear the fields of their noxious insects by means of the subtle electric fluid.

Upon this work and its more or less satisfactory outcome, Mr. Helberger has just furnished us with detailed information. But before we place this newly-acquired knowledge before our readers, it will be, no doubt, interesting to them to note what had been done in advance of these experiments, and for this purpose it will be necessary for us to go back a little.

Several years ago, at Ischeiplitz, near the city of Freiburg, Switzerland, rather exhaustive attempts had been made with a new method for destroying by means of ozone the phylloxera, that voracious aphid which, transported from our shores in some mysterious manner, had attacked and made such havoc among the grape vines all over Europe. Although the scheme emanated from the fertile brain of a distinguished wine grower, Mr. Puchs, proprietor of the extensive vineyards at Porto Ferrario, on the island of Elba, and at the same time an electrical engineer attached to the Siemens & Halske Company, of Berlin, this method did not make the returns expected from it.

More fortunate were the experiments made at Frani in 1901, with the assistance of Mr. Palumbo Domenico, for the extermination of insects other than the phylloxera. The method there pursued consisted merely in electrocuting the little pests fixed upon the root or stalk of the plant by getting them between points of sufficiently differing electric potential. One form of the apparatus consisted of an oscillator, which on the one hand was connected with the earth by grounding, while the other pole, through the interposition of a Leyden jar, was joined electrically to the trunk or stalk of the growing plant. From the moment that the oscillator began to work, the little insect upon the root wherever he happened would establish a connection between one point of a certain potential, the roof itself, and another point, the potential of which was equal to zero, viz., the earth; in plainer words perhaps, he would involuntarily complete the circuit, the discharge from the loaded Leyden jar would pass through him, and he would be literally struck by lightning.

If the insect had been upon the stalk, he would still have provided a path of less resistance for the electric fluid. By virtue of the law governing induced currents, he would have also been in the way to intercept a current of sufficient intensity to kill him. These experiments were undertaken against worms and other small vermin. With this insight into what had been previously accomplished, we shall take up Mr. Helberger's interesting attempts.

The wonderful effect of the electric fluid upon the lower organisms was of purely accidental discovery. This distinguished engineer was therefore led to his

attempt to drive from certain portions of the soil the worms, snails, and other noxious insects which infest it, by an accidental observation made while at work upon the experimental drying by electricity of an ingot mold built directly in the ground.

After the current had been turned on for a few moments, Mr. Helberger incidentally remarked that, out of the ground adjacent to the mold, worms were coming hurry-skurry, as if pursued by some unseen antagonist, and doing their utmost to flee from the disturbed locality. He also observed that on passing from one clod to the next they were thrown back, rearing up and contracting convulsively.

In his opinion, these actions on the part of the worms could only be attributed to the influence of the electric current. In fact, they ceased when the flow was shut off.

Following up these observations, Mr. Helberger undertook several tests calculated to prove or disprove his hastily conceived theory. Among others, he buried in the ground a bar of brass about half a centimeter thick, and connected it with one pole of an electric conductor carrying a current of 110 volts. Upon turning on the current, the results of this arrangement far exceeded what he had only chanced to observe in connection with the ingot mold, for within a radius of two meters every worm or insect, till then snugly ensconced within the lap of friendly Earth, came to light and hurriedly sought safety in flight to securer positions, which were apparently only attainable beyond the electrified circle. Carrying the idea further, he now increased the electrified circle by planting other brass electrodes in the earth, and, in a shorter time than it takes to tell it, freed the surrounding terrain of all that it contained in the nature of crawling or creeping things. In itself the current is very small or weak, only the tension must be high.

These experiments opened to the thoughtful mind a wide field. If the practical application of the electric fluid to the earth should work such wonders upon uncultivated ground, what might not be the benefit which would accrue to agriculture in general if applied upon a vast or at least a more extended scale? Surely, he thought, a plant, the roots of which are free from attack by worms, snails, beetles, and what not, must thrive and flourish far beyond one which was continually under tribute to these subterranean depredators.

It is now generally admitted without contention that the virtual extermination of these harmful insects from the neighborhood of growing plants, by means of the electric fluid, is a happy circumstance for agriculture; indeed, the experiments undertaken by Mr. Palumbo verified this fact in 1901, not accidentally, as was shown above, but by methodically bringing some worms and ants between two portions of earth connected to an electric generator. If our readers possess sufficient interest to investigate these trials, an account of them will be found in the issue of the Revue de l'Electricité, which appeared at Berne, Switzerland, on the 31st of January, 1903. It cannot be admitted, however, as some scientists and others seem to think, that electricity is baneful to the soil just because it does drive away these worms and insects.

Quite the contrary is shown by the results of the researches and experiments undertaken by Mr. Lemstroem, a professor at the University of Helsingfors, not to mention other investigators, all of which go to prove the beneficial influence of electricity upon vegetation.

This mysterious influence so powerfully exerted is explained in this wise: The passage of the electric fluid causes the electrolysis of the salts contained in the soil, decomposes them, in other words, and recomposes, or forms them into new compounds or salts more easily assimilable by the plants; again, it excites new vigor in the vitality of the plant, and in that way favors the interchange of gases between the leaves on the one hand and the surrounding atmosphere on the other; it, moreover, actuates the respiratory organs, aids the fixation of the carbon, assists the transpiration, the nutrition, and the multiplication of the cellules; in fine, it urges on the ascension of the sap by stimulating osmosis and by causing the life-giving fluid to penetrate into the farthest recesses of the capillary vessels of the tissues of the plant.—Translated from Cosmos.

SOME EXPERIMENTS ON THE ELECTRICAL CONDUCTIVITY OF ATMOSPHERIC AIR.*

By J. C. McLENNAN, Ph.D., Associate Professor of Physics, University of Toronto, and E. F. BURTON, B.A., Fellow in Mathematics, University of Toronto.

I. INTRODUCTION.—In a paper by H. Geitel† reference is made to a gradual increase observed in the conductivity of a mass of atmospheric air after being confined in an air-tight chamber. This effect was found to require from four to five days to reach its maximum value and was observed in localities where no thorium compound or other known radioactive substances existed. In a subsequent investigation Elster and Geitel‡ found that air which had been confined for some time in closed caves or house-cellars possessed an abnormally high conductivity. This phenomenon, together with the observed increase in conductivity mentioned above, they concluded, could not be due to the presence of dust or water vapor. They traced it rather, in both cases, to the existence of some undetermined radioactivity in the confining walls. More recently these physicists* discovered that atmospheric air possessed the property of exciting induced radioactivity in bodies exposed under negative electrification. This phenomenon of induced or excited radioactivity had been previously observed by Rutherford† in bodies exposed to air drawn from the neighborhood of thorium compounds and had been connected by him very directly with an emanation which these salts emit. This emanation he found possessed the property not only of exciting radioactivity in all solid substances in the neighborhood, but also of ionizing any gas with which it was in contact.

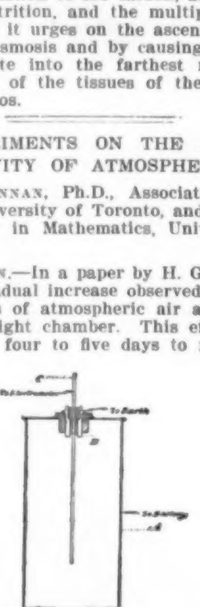


FIG. 1.

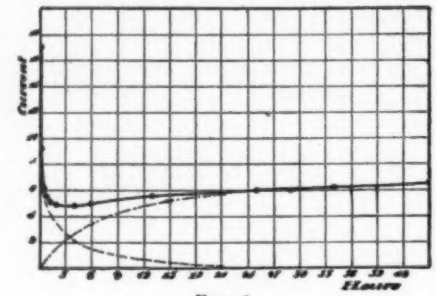


FIG. 2.

Since atmospheric air has been shown by Elster and Geitel,‡ C. T. R. Wilson,§ and others to be continually ionized by some agent, and since it has also been shown to possess the property of exciting radioactivity, one is forced to conclude that there is present in the air an emanation possessing properties similar to that emitted by thorium compounds. Hitherto the source of such an emanation has not been determined, but, as the phenomena of induced radioactivity and spontaneous ionization universally characterize atmospheric air, it seems evident, since thorium compounds are but sparsely distributed in nature, that sources other than these must exist.

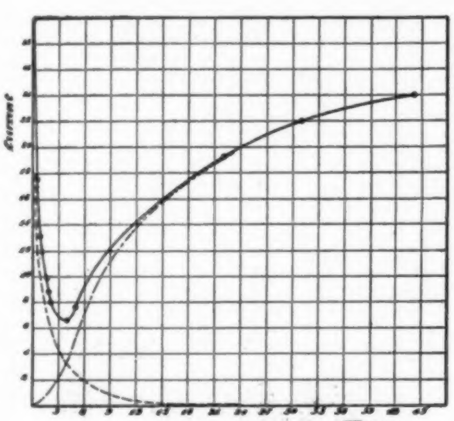


FIG. 3.

Recalling the experiments of Elster and Geitel, it seems probable that the earth's surface, and possibly too, the material used in the construction of their apparatus, are sources of this emanation. As but little evidence existed in favor of this conclusion, the writers recently made a series of observations upon atmospheric air confined in air-tight vessels of different metals. The result of the investigation showed that the conductivity of the inclosed air depended very largely upon the material of which the receiver was made, and the effects observed would seem to indicate that all metals in varying degree are the sources of a marked though feeble radioactive emanation.

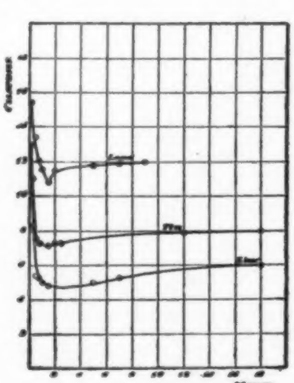


FIG. 4.

II. Apparatus.—In these observations the air whose conductivity was to be measured was confined in a cylinder 125 cms. in length and 25 cms. in diameter, similar to that shown in Fig. 1. In the first experiments it was made of sheet iron coated with zinc, and in the later experiments linings of various metals were inserted in order to examine their effect upon the conductivity of the inclosed air. The bottom and cover were removable, and, when in position, were made air-tight by means of cement. Into a flanged opening in the cover was fitted an ebonite plug about 5 cms. in diameter. A brass tube, *B*, was passed through this and into it a second ebonite plug was tightly fitted. The second plug carried a brass rod, *C*, which extended almost to the bottom of the cylinder. The brass tube *B*, which was earthed throughout the measurements, served as a guard ring and prevented any leak from the vessel to the rod, *C*, across the ebonite plugs. The conductivity was measured by placing the cylinder upon an insulated platform, charging it by means of a set of small storage cells to a potential of 165 volts, which sufficed for the saturation current, and observing the rise in potential of the electrode, which was joined to a quadrant electrometer in the usual manner. The sensibility of the electrometer was such as to produce a deflection of 1,000 millimeters on the scale for a potential difference of one volt between the quadrants.

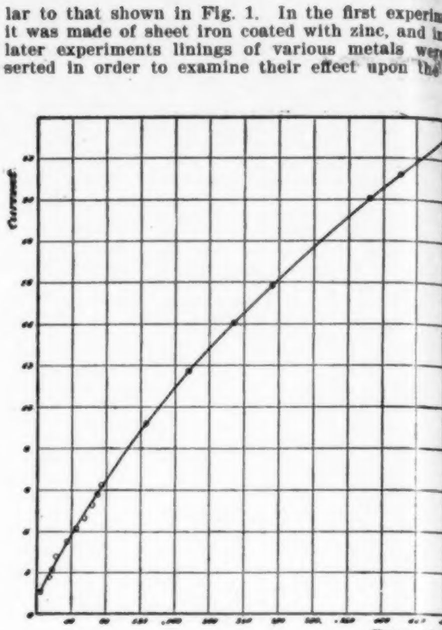


FIG. 5.

III. Conductivity Measurements: Time Effect.—Before inclosing air for examination, the cylinder was placed in an open window in the laboratory, with the ends removed, and the air allowed to blow through it for some time. The top and bottom were then replaced, cemented in position, and the cylinder connected with the electrometer as quickly as possible. Measurements on the conductivity were made at intervals of a few minutes at first, and it was invariably found that a rapid decrease in the ionization took place until a minimum value was reached. The conductivity then slowly increased and approached a limiting value in the course of two or three days.

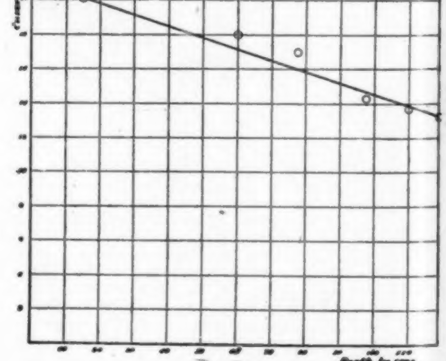


FIG. 6.

TABLE I.—CURRENT: ARBITRARY SCALE.

Time.	Pressure—501.0 cms.	Pressure—74.2 cms.
10 mins.	30.0	17.1
15 "	....	9.3
30 "	17.5	6.2
50 "	13.2	5.5
1 hour	12.0	....
1.25 "	....	5.13
1.5 "	9.9	....
1.75 "	8.9	5.1
2.00 hours	8.0	4.9
4.00 "	6.6	4.8
5.00 "	7.6	....
6.00 "	....	5.0
10.00 "	....	5.8
22.00 "	19.2	....
25.00 "	....	6.0
29.00 "	....	6.0
32.00 "	22.0	....
34.00 "	....	6.3
44.00 "	24.0	....
45.00 "	....	6.5

* Read before the American Physical Society at Washington, December 31, 1902.
† Phys. Zeit., ii, pp. 116-119 (1900).
‡ Phys. Zeit., ii, pp. 560-563 (1901).

* Phys. Zeit., ii, p. 590 (1901).
† Phil. Mag., No. 49, pp. 1 and 161 (1900).
‡ Loc. cit.
§ Proc. Roy. Soc., vol. 69, pp. 277-282 (1901).

In repeated tests carried out in this manner with the zinc cylinder it was found that, while the initial conductivity varied from day to day, there was always observed a rapid decrease to a constant minimum followed by a gradual rise to a constant limiting value. A typical set of values for the conductivity of air confined in the zinc cylinder at atmospheric pressure is given in the third column of Table I, the currents being expressed in arbitrary units, and the times being taken from the closing of the cylinder. The ionization curve for these values (Fig. 2) shows that the minimum current, 4.8, was reached in about four hours after the air was inclosed. After about eighteen hours the curve indicates that the conductivity was tending toward a limiting value, which the reading taken after forty-four hours showed to be about 6.5.

As a variation in the experiments, a series of tests was made with air confined in a receiver at high pressures. The cylinder in this case was of heavy rolled iron, coated with zinc, and was of the same dimensions as that formerly used. The results of observations on the conductivity of air confined at a pressure of about seven atmospheres are given in the second column of Table I, the scale used being the same as before. The curve representing these values is shown in Fig. 3, and exhibits the same characteristics as that for the lower pressure. We have again the rapid decrease to a minimum, followed by a gradual rise tending toward a limiting value. The minimum conductivity in this case was about 6.6, and was reached in about four hours after the required pressure in the cylinder had been obtained. The time occupied in pumping the air was about one hour.

In seeking for an explanation of the curves shown in Figs. 2 and 3, their twofold origin, as indicated by the dotted lines, is at once suggested by the conductivity in the initial stage being due to an agent subject to rapid decay, and that in the second to one whose power shows a gradual increase. The first of these dotted curves is similar to that given by Rutherford* for the conductivity of the air in a chamber which has been cut off from a second containing thorium oxide after the two had been in communication for some time. The second dotted curve is similar to that given by him for the conductivity of the air in a chamber which had been placed in communication with one containing thorium oxide.

It will thus be seen that the first portion of the curves in Figs. 2 and 3 can be explained upon the supposition that a radioactive emanation, probably having its origin in the earth's surface, was introduced into the cylinder with the air, the decay in this emanation being the cause of the decrease in the conductivity, and the second portion upon the supposition that a radioactive emanation is given off by the walls of the containing vessel. On this view, the limiting value to which the conductivity curves tend would represent a condition of equilibrium, where the rate of decay of the emanation is equal to the rate at which it is produced.

As both the low and the high pressure cylinders were made of the same material and were of the same size, one would expect the same amount of the emanation to be present in both when the steady state was reached. With an easily absorbed radiation from this emanation, we should obtain a limiting conductivity independent of the pressure. But, since a very great difference was found in the limiting conductivities at the two pressures, it would appear that the radiation possesses considerable power of penetration and is not easily absorbed.

The difference in the initial conductivities given in the second and third columns of Table I may also be readily explained by the difference in the air pressures. The time required to fill the high pressure cylinder and the decay taking place during that time in the emanation introduced with the air preclude a comparison of the amounts of active emanation present in each cylinder when the first observations upon their conductivities were made; but if the amount in the high pressure cylinder were equal to or greater than that in the low pressure cylinder, the difference in the initial conductivities is explained, while, if it were less, the greater density of the air in the high pressure cylinder and the consequent greater absorption would still account for the higher conductivity.

IV. Effect of Different Metals.—To ascertain whether the conductivity of the air inclosed was affected by a change in the metal composing the walls of the receiver, linings of tin and lead were in turn fitted into the zinc cylinder used in the first experiment. Tests of the conductivity were made both with and without the tin and lead linings. Before each test the cylinder was well aired and sealed in the manner already described. As soon as the air was inclosed, measurements on the conductivity were begun and continued at stated intervals as before.

TABLE II.

Time.	Current: Arbitrary Scale. Zinc.	Tin.	Lead.
10 mins.	13.0	13.0	15.4
15 "	8.3	11.0	....
30 "	5.4	7.6	13.4
45 "	5.3	7.3	12.1
1.0 hours	5.0	....	11.55
1.5 "	4.85	7.2	10.8
2.0 "	....	7.3	11.5
2.5 "	....	7.3	....
5.0 "	5.0	....	11.8
7.0 "	5.3	....	11.9
9.0 "	....	....	12.0
12.0 "	....	7.9	....
18.0 "	6.0	8.0	....

The values obtained for the conductivity with each of the metals are given in Table II, and curves representing these values are shown in Fig. 4. The curves for the different metals, it will be seen, have the same characteristics. In each there is a rapid drop to a minimum and a gradual rise toward an ultimate limiting value. It is interesting to note that a considerable difference was found in the minimum conductivities for the three metals, and that the final limiting values also varied. The decay of an emanation introduced into the cylinders with the air would again account for the first portion of the curves, a radioactive emanation from the metallic walls would explain the existence of the second portion; while the differences in the minimum and limiting values may be considered to have their origin in variations in the rate at which the emanation is given off by the different metals. In this connection it will be noted that the limiting values of the conductivities range according to the atomic weights of the metals, lead having the highest, tin the next, and zinc the lowest.

V. Effect of Variations in Pressure.—In order to investigate the relation between the conductivity of air and the pressure at which it was confined, the heavy cylinder was filled to a pressure of about seven atmospheres and allowed to stand for some days until its conductivity assumed a constant value. The air was then allowed to escape gradually, and the pressure reduced from 501.0 cms. to 4.4 cms. of mercury, the conductivity being measured at these and at various intermediate pressures. The results are given in Table III, and the conductivity curve in Fig. 5.

TABLE III.

Pressure in Cms.	Current: Arbitrary Scale.
501.0	23.5
481.0	22.7
420.0	21.2
384.0	20.3
272.0	15.8
227.0	14.1
176.0	11.7
125.0	9.3
74.2	6.5
69.3	5.8
62.0	5.4
53.0	4.7
44.2	4.2
35.0	3.5
22.4	2.7
18.2	2.2
14.0	1.8
4.4	1.1

The ionization curve so nearly approaches a straight line that we may almost conclude, in view of the wide range of the pressures examined, that the conductivity was proportional to the pressure. This result is what we should expect to obtain with an emanation maintained at a constant strength and emitting a radiation of a penetrating nature.

VI. Penetrating Rays from External Sources.—While the effects described up to the present may be explained by supposing the ionization to be caused by a radioactive emanation sent off from the metals, it has been found that part of the conductivity cannot be accounted for in this way, but must be attributed to an active agent external to the receiver.

The heavy cylinder referred to above was filled with air to a pressure of about 400 cms. of mercury and allowed to stand until its conductivity had become steady. It was then placed in an insulated galvanized iron tank, 1.5 meters in height and .75 meter in diameter, which was gradually filled with water so as to surround the cylinder with a layer 25 cms. in thickness. The initial conductivity before the water was admitted was 21.1. As the water rose the conductivity decreased and fell to 13.3 when the tank had been filled. The values for the conductivity during the experiment are given in Table IV and are represented by the curve shown in Fig. 6. From these values it will be seen that the loss was almost directly proportional to the rise of the water, and that the total fall in conductivity was about 37 per cent.

TABLE IV.

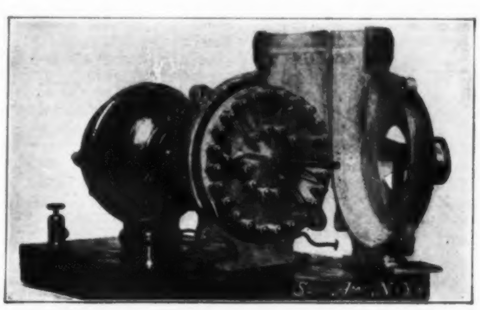
Depth in Cms.	Current: Arbitrary Scale.
0.0	21.1
15.0	20.5
60.0	18.0
77.0	17.0
97.0	14.3
110.0	13.75
120.0	13.3

The experiment was repeated with the cylinder placed in a tank 50 cms. in diameter. This tank permitted the cylinder to be surrounded by a layer of water 12.5 cms. in thickness, and it was found when the water was poured in that the conductivity fell off 17.5 per cent.

From these results it is evident that the ordinary air of a room is traversed by an exceedingly penetrating radiation, such as that which Rutherford has shown to be emitted by thorium, radium, and the excited radioactivity produced by thorium and radium.

In order to reach definite conclusions regarding the extent and true character of the effect of various metals upon the conductivity of the air which they inclose, it would be necessary to entirely cut off the inclosing vessel from the action of any external radiation, and the writers have not yet carried their experiments to this point.

* Phil. Mag., January, 1900, p. 6.

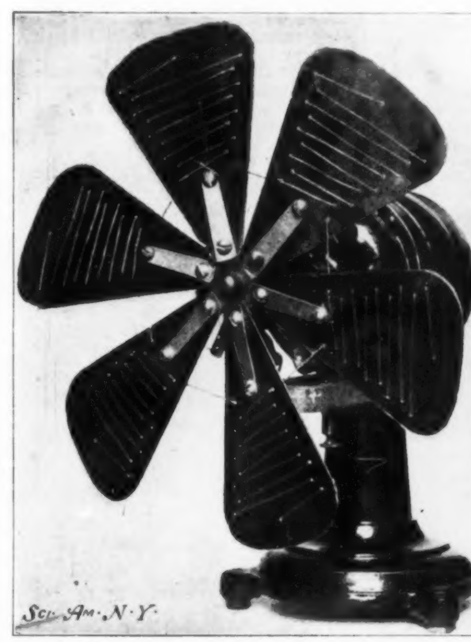


THE DE MARE ELECTRO-THERMIC FAN AND CASING.

THE DE MARE ELECTRO-THERMIC FAN.*

By EMILE GUARINI.

MR. DE MARE, a distinguished electrician of Brussels, has invented an electro-thermic fan. The apparatus consists of an electric motor and a rotating fan, the blades of which are of mica. Upon these mica blades are fastened resistance coils, which are heated by the passage through them of a current of electricity. The temperature of these coils should be carried as high as possible, first because the temperature of the surrounding medium—air—is increased, and again because the efficiency of the radiator is also augmented in this manner. Let us suppose the coil to offer a resistance equivalent to 100 ohms while a current of 10 amperes is passing through it. Joule's law teaches that the amount of energy consumed in the form of heat will be equal to the resistance multiplied by the square of intensity, which in the example above will be $100 \times 10^2 = 10{,}000$. If we double the intensity of the current and neglect the increase of resistance offered by the wire by reason of the elevation of the temperature at which it passes, we shall obtain the equation $100 \times 20^2 = 40{,}000$, which represents a fourfold development of heat. This, except in part, is not always exact; for the higher we raise the temperature, the more luminous does the resistance coil become and the greater will be the loss of energy. From experiments conducted during the last exposition at Antwerp, I learned that the glowing power of a resistance—the power sufficient to produce a certain degree of glow in a given coil—increases, in certain cases at least, with the sixth power of the intensity of the current, that is to say, if a given current be doubled, the luminous intensity will be 64 times as great. From this may be deduced that as far as electric heating is concerned, the ideal conditions would be those which, while setting the air in motion, would allow of carrying the resistance coils up to a very high temperature without producing luminous phenomena.



THE DE MARE ELECTRO-THERMIC FAN.

This is just the problem which De Mare has solved, and we give below the manner in which he has accomplished it. First of all, he made the following experiment. After raising the resistance coils to a white heat he started the fan, and I observed the interesting phenomenon that the turns of the coil nearest the center of the fan became black, viz., cooled down, while those situated nearer the outer edge or periphery remained in a glowing state. The faster the fan turned, the more marked was the phenomenon. It is explained in this wise: At the center an increase of pressure or extra density of the air was produced, while at the outer portion of the fan a certain rarefaction was generated. A second experiment was made with a platinum wire through which a current of sufficient intensity was caused to flow.

This wire fused in the rarefied air at the circumference, remained glowing in the air at ordinary pressure, but became black in the compressed air at the center, at the same time getting hotter. This rather paradoxical condition arose from the fact that while compressed air is a poor conductor of electricity, it is an excellent conductor of heat.

The wire alone produces the heat which is rapidly absorbed by the compressed air. This absorption of the heat by the air prevents the temperature of the wire from rising to the fusing point. From these experiments with the electro-thermic fan of Mr. De Mare it is but a single step to practical results. The inventor achieves this end by inclosing his radiating fan in a casing provided with an opening resembling that of an ordinary power blower. When the fan is in motion, the air is compressed in the casing.

The pressure of the air upon the resistance coils revolving in it is almost uniform at every point. When the fan turns and a current of electricity is passed through the coils, a very lively heat, an insupportable

* Specially prepared for the SCIENTIFIC AMERICAN SUPPLEMENT.

heat, issues from the mouth of the casing. In the experiments made before me Mr. De Mare allowed the revolving fan to attain a satisfactory speed before turning the electric current through the resistance coils. The wire, which, while the fan was in motion, glowed but dimly, was in fact so thin that the current employed—20 amperes—would readily have caused it to melt at the ordinary air pressure.

THE LIGHT ALUMINIUM ALLOYS.*

By Dr. Joseph W. Richards.

Pure aluminium, like pure gold, silver or copper, is a comparatively soft and weak metal; it has many of the properties of copper, being easily cut by a knife and having a fibrous, silky fracture. The pure metal hardens quickly while being worked, faster when worked cold, and becomes harder, denser, more elastic and stronger, but soon goes to pieces if worked too far. The hard drawn aluminium wire or hard rolled sheet or rod have strong physical resemblances to hard drawn or hard rolled copper. To produce thin sheet or fine wire it is necessary to anneal frequently, to remove the strains caused by the working. Castings of aluminium, unworked, are soft and weak.

The following table gives the usual limits of physical properties of number 1 commercial aluminium, which averages 99 to 99.5 per cent pure:

	Elastic limit. (Pounds per square inch.)	Ultimate tensile strength. (Pounds per square inch.)	Percentage reduction of area.
Castings..........	8,500	14,000 to 18,000	15
Sheet..............	12,500 to 25,000	24,000 to 40,000	20 to 30
Wire....	16,000 to 34,000	25,000 to 55,000	40 to 60
Bars................	14,000 to 23,000	28,000 to 40,000	30 to 40

For all purposes where the rolled, drawn, or worked pure metal is sufficiently hard and strong it is advisable to use the pure metal, since it resists alteration by the atmosphere and other corroding agencies better than almost any of its alloys, and better the purer it is. For cast articles, and wire, rod, or sheet which are not sufficiently strong or hard when made of the pure metal, the aluminium can be allowed with small quantities of other metals, which improve it in various ways, without materially increasing its specific gravity. Pure aluminium has a density of 2.6 to 2.7, while the light alloys of which we shall treat contain up to 33 per cent of foreign metals, and range in density from 2.4 to 3.6. The principal metals which have been proposed or used for these alloys are zinc, copper, nickel, magnesium, titanium, tungsten, chromium, manganese and silver.

ALLOYING THE METALS.

The components of the alloy should be of as pure a quality as it is possible to get them. The aluminium used should be of No. 1 quality, which averages now 99.5 per cent aluminium. For the very best results the extra quality, sold as 99.75 pure, should be used. The commercial qualities of the other metals are frequently so impure that they give alloys of quite different properties from the pure metals. This is particularly true of zinc, the ordinary Western brands of which contain 1 per cent or more of lead and often considerable iron. In this case it pays to purchase the redistilled zinc or the best varieties of Bertha or Sterling spelter.

As a general rule, it is advisable to melt the aluminium first, and then to stir or dissolve the other metal into it. Most metals, particularly copper, unite with aluminium with considerable energy, and dissolve quickly in it, even though their melting point may be considerably higher. To facilitate the solution of a metal of very high melting point, such as nickel, it is advisable to prepare first an alloy of the metal with aluminium in somewhat like equal proportions. This alloy, cast into bars, is then added to the melted aluminium, and dissolves much faster and more uniformly than the pure metal.

The melting can ordinarily be performed in graphite or plumbago crucibles in a melting hole. The crucible should stand on a refractory pedestal, to keep the bottom from being chilled should the fuel be burnt out beneath it, and to avoid its tipping. It should be covered tightly, in order to avoid absorption of gases, or the accidental dropping in of coke. If the alloying is being performed, the metal is best kept covered with lumps of charcoal, to keep air from striking the surface, but this is not needed or recommended if the operation is simply a melting.

Since the fire is hotter than the crucible, and the crucible wall hotter than the metal inside, it is of great importance that the fire be not too hot and the metal not overheated. Aluminium alloys, like aluminium, have large specific heats, and it takes a large amount of heat, though not a high temperature, to melt them. The characteristic of the furnace operation is therefore to have only a moderately hot fire, and then wait with patience until the metal melts, which will take from 30 to 50 minutes, starting with a cold crucible. The disadvantages of overheating the metal are three, viz.: It absorbs more gases; it will probably be poured too hot and segregate in the mold; it will react on the crucible itself, reduce from it iron and silicon, and become brittle. It is of the greatest importance that the alloy be never over a cherry red heat, and it should never adhere to or wet the crucible. The stirring rod may be iron, preferably a wrought-iron bar, if the temperature is carefully kept low. If the temperature is too high the iron bar will be wetted and corroded and the alloy injured. Until experience has been gained, it is better to use a carbon rod for a stirrer, fastened into the end of an iron pipe for a handle.

When the alloying metal has been all dissolved, the whole is stirred vigorously and cast at once. Letting it stand some time in the furnace produces a somewhat closer alloy, but the deterioration caused by increased gases and impurities taken up from the crucible usually overbalances the gain. After taking from the furnace, the crucible should be placed on some firebricks and the metal stirred as it cools, and it should be cast only just hot enough to properly fill the mold. If cast too hot it is apt to segregate while cooling.

* A paper read before the American Society for Testing Materials, at Delaware Water Gap, July 3, 1903.

The use of a flux in the crucible is in no case recommended, since it attacks the walls of the same, facilitates the reducing action of aluminium upon them, and injures the alloy. With careful regulation of temperature and use of no flux, a good crucible will last almost indefinitely, not being wetted or corroded. Iron skimmers or ladles may be coated inside with a wash composed of finely ground bauxite mixed with a little lime. This is practically unattacked by any alloy. Magnesia lined crucibles are best for this work, when they can be gotten.

With some metals there is a limit to the amount which aluminium can take up. Thus, it can keep in solution only 1.92 per cent of lead, or 3.39 per cent of cadmium, while it will mix with most of the other metals in all proportions.

MELTING POINTS.

Almost all the light, strong alloys melt easier than aluminium. The addition of a few per cent of any metal to aluminium lowers the melting point, even though the metal added has a high melting point. There is a limit, however, in some cases, to the amount of foreign metal which can be taken up without increase of melting point. Adding copper, the melting point decreases until 33 per cent of copper is present, above which it rises. Antimony is the most striking exception, for small quantities increase the melting point very considerably; 33 per cent of antimony makes an alloy melting only at 230 degrees higher than aluminium and 250 degrees higher than antimony. Of the commercial alloys, however, containing small percentages of zinc, copper, nickel, or magnesium, it may be said that they melt either as easily as or slightly more easily than aluminium itself.

SPECIFIC GRAVITY.

The alloys with magnesium, 2 to 12 per cent, are the only ones which are lighter than aluminium itself; but they are lighter than their composition and the specific gravity of magnesium (1.72) would lead us to expect. Thus, 10 per cent of magnesium would theoretically make a physical mixture with a specific gravity 0.16 less than aluminium, whereas it really gives an alloy 0.24 lighter. This points to expansion taking place during alloying, in this case. In the case of the other metals heavier than aluminium, their specific gravity is usually higher than would be calculated from the composition, pointing to a condensation or contraction taking place in alloying. In fact, with small percentages of copper, iron, and nickel, the contraction taking place in alloying is so great that the alloy occupies less volume than the aluminium alone entering into it. In these cases it appears as if the molecules of alloying metal slip in between the molecules of the aluminium, thus accounting for the increased hardness and tenacity of the alloy. The magnesium alloys range from 2.4 to 2.57 in specific gravity; the heavier metal alloys from 2.6 to 3.6. In general the light aluminium alloys are one-fourth to one-half as heavy as the structural metals which they replace.

MOLDS.

For general castings a loose texture green sand is suitable. Numerous air vents must be supplied, and a large casting gate and heavy feeders at heavy parts of the casting. In such molds the alloys are poured cold, and as fast as possible, to prevent chilling. In spite of this the slow cooling renders the alloy ununiform by segregation, and therefore not so strong as chilled castings. To partly avoid this the castings are shaken loose from the sand as soon as they are set. Slabs and rods for rolling and drawing are cast in chill molds, as are also any objects needed in large quantities. This makes the material soft, uniform and stronger than if cast in sand with a smoother surface.

WORKING AND ANNEALING.

All these alloys are hardened and stiffened by working and must be frequently annealed to avoid cracks and breaks. The slabs and billets are best broken down, while warmed to 150 to 250 degrees C., under a steam hammer; afterward steel rolls with good surfaces are used, and about as much power is required as for rolling hot steel of similar section. Imperfections in the casting must be scraped or gouged out before breaking down. Slabs are usually rolled two passes lengthwise, increasing the length 20 per cent, and then are turned to 90 degrees and rolled out further. The rolls should be at 150 to 200 degrees C., and if polished sheet is required the sheet is polished before being sent through the final polishing rolls. Working raises the tensile strength but decreases ductility and frequent annealing is necessary.

The annealing is done in a muffle, if possible, as it is advisable not to subject these alloys, especially magnalium, to the direct action of the flame, since absorption of gas and internal oxidation, or burning, takes place at redness without melting. Slabs and bars are heated to full dark red, so that a pine stick carbonizes when drawn over them. Sheet must not be heated so high; a thin sheet is merely warmed to about 400 degrees C. and then cooled in water. Very thin sheet can be put into hot oil and this allowed to cool slowly.

DIPPING AND FROSTING.

Alloys with magnesium or zinc can be given a pure, white silvery surface by putting into a 10 per cent caustic soda solution, containing 2 per cent of common salt and warmed to 60 degrees C. The object is kept 15 to 20 seconds in this, until a violent evolution of gas appears, then washed in cold water and brushed; then dipped 10 to 15 seconds in concentrated nitric acid, again washed in cold water, and then dried in fine, warm sawdust. The soda solution is held in an iron vessel; the nitric acid in clay, porcelain, or slate. The dipping is particularly recommended for rolled slabs, after the first annealing, as any casting defects are thus shown up, and can be eradicated by cutting out or using emery paper. By repeated dipping a fine, silky matte is obtained, which is absolutely unalterable in air. For alloys containing copper or nickel the soda solution is replaced by dilute hydrofluoric acid. A dull black finish may be obtained by using dead India black varnish and keeping one hour at 100 deg. C. A shining black can be obtained by using black stove varnish and keeping one to one and one-half hours at 50 deg. C.

ALLOYS WITH CHROMIUM.

Chromium hardens aluminium strongly, the alloys having somewhat of the qualities of self-hardening steel—i. e., retaining their hardness on heating or after annealing much better than any other of the aluminium alloys. Two to 3 per cent of chromium is recommended as making the metal much harder but decreasing malleability considerably. Eleven per cent makes the alloy brittle, crystalline, and unworkable; 3½ per cent makes an alloy which can be hammered and rolled, but is very stiff and "crackelly." Its mechanical properties are given by Lejeal as:

	Tensile strength (Pounds per square inch.)	Elongation. (Per cent.)
Hard rolled........	18,000	1[illegible]
Annealed	17,500	7

Prof. Langley made 2 and 3 per cent alloys by dissolving chromium oxide in a bath of melted fluorides of aluminium, sodium, and calcium, and then pouring in metallic aluminium in the required quantity. Chromium alloys are being used commercially at present, but the writer cannot say to exactly what extent.

ALLOYS WITH TITANIUM.

Alloys up to 7 per cent of titanium have been made, but the best is that with 2 per cent. This has elasticity comparable to spring brass, and a tensile strength of 30,000 to 35,000 pounds when rolled hard with 3 per cent elongation, and 21,000 pounds when annealed, with 16.5 per cent elongation. These alloys are difficult to make, as pure titanium is rare, and the only practicable method of manufacture is to dissolve titanic oxide in melted cryolite and add aluminium, which latter reduces the oxide and forms an alloy with the metal. If chromium oxide is added also a triple alloy of chromium, titanium, and aluminium is obtained, which is very hard and rigid, and holds a cutting edge fairly well. The titanium alloys have a dull, leady color, and are corroded more rapidly than many other of the aluminium alloys, so that their use has practically disappeared.

ALLOYS WITH MANGANESE.

A. H. Cowles patented some years ago the addition of manganese to commercial aluminium up to 5 per cent, producing particularly hard and rigid alloys. They can be made either by making a rich alloy of manganese and aluminium in the electric furnace, and diluting this down with pure aluminium, or by adding manganese oxide to the electrolytic bath in which aluminium is being produced in quantity sufficient to form the desired alloy with the aluminium of the alumina being decomposed. The addition of rich ferromanganese to aluminium also serves to produce the alloys, but it has the disadvantage of introducing some iron and carbon into the alloy at the same time. Susini makes a series of alloys of aluminium with 3, 5, 8, or 10 per cent of alloying metals, the latter being zinc, copper, and manganese. He makes the alloy of the three latter in a graphite crucible, melts the required quantity of aluminium at a red heat and then pours the liquid alloy into it. The three alloys he recommends must contain in percentages:

Manganese.	Copper.	Zinc.
1 to 3	1.5	0.5
1 to 5	2.5	1.0
2 to 8	4.5	1.5

Used with copper and nickel, manganese makes the hardest light alloy of aluminium yet produced.

ALLOYS WITH TIN.

The alloy of aluminium with 10 per cent of tin was strongly recommended by Mr. Bourbouze. It is whiter than aluminium, its density is 2.85, its coefficient of expansion by heat is less than that of aluminium and it can be more easily soldered than pure aluminium. The tensile strength of a casting of this alloy showed only 14,000 pounds per square inch, with 4 per cent elongation, so that it is no stronger than pure aluminium and not as ductile. The alloy is said to be improved by the addition of 3 per cent of nickel. As far as the writer is informed, the use of this alloy has disappeared. Tin is still used in some of the other light aluminium alloys, in small quantities of not over 2 per cent to contribute to the easy fusibility of the alloy and to decrease the shrinkage. If phosphorus is simultaneously desired in the alloy the commercial phosphor tin is employed.

The best material for soldering aluminium is an alloy of 29 parts tin, 11 parts zinc, 1 part aluminium and 1 part of 10 per cent phosphor tin—patented by the writer's father. This alloy, however, is only 2.4 per cent aluminium, and belongs to the heavy alloys.

ALLOYS WITH SILVER.

Aluminium will absorb up to 5 per cent of silver without increasing in volume; the alloys thus made are whiter, harder, denser, and stronger than pure aluminium, and take a high polish, which they retain better than almost any other alloy of aluminium when exposed to corrosion. For the latter reason, particularly, they have been used since the early days of the aluminium industry, particularly when aluminium itself was almost as high priced as silver, for opera glasses, telescopes, statuettes, fine light weights, the beams and hangers of fine balances, fine instruments and electrical apparatus. Alloys up to 10 per cent of silver can be worked, and 1 to 2 per cent of copper is simultaneously used to reduce the cost of the silver by partly replacing it. Alloys with 3 per cent silver have been used for statuettes, with 5 per cent for dessert spoons, fruit knives, and watch springs, with 3 per cent silver and 2 per cent copper for balance beams, with 5 to 9 per cent silver and 1 per cent copper for cast dental plates. Where cost is a secondary consideration, and fine grain, fine color, and unalterability are of first concern, the silver alloys are evidently still of some economic importance. The atomic weight of silver (108) is exactly four times that of aluminium (27), and their specific gravities are in the same ratio, and it is probable that this has some connection with the characteristic improvement

in color, grain and resistance to corrosion which these alloys show.

ALLOYS WITH NICKEL.

As far as the writer can find out, alloys of aluminium with nickel alone have not been found advantageous. Lejeal prepared an alloy with 4.5 per cent nickel, which had a coarsely crystalline fracture, rolled and worked well, but had poor mechanical properties. The commercial alloys which go under the name of nickel-aluminium alloy are in reality ternary alloys of aluminium with nickel and copper. The alloys made for rolling contain 2 to 5 per cent of nickel and copper together, the larger part being usually copper. The plates of the yacht "Defender" were made of this alloy. They were very satisfactory mechanically, showing an average elastic limit of 30,000 pounds per square inch, ultimate strength 40,000 pounds, with 10 per cent elongation in 2 inches and 15 per cent reduction of area. The specific gravity was 2.75. The plates were unfortunately fastened in place by steel rivets and were not insulated from the Tobin bronze sheathing below the water line, with the consequence that the aluminium plates were badly corroded in two years' time.

What are called nickel-aluminium casting alloys contain 7 to 10 per cent of nickel and copper together, have a specific gravity of 2.80 to 2.85, contract 3-16 inch in setting, and have, in castings, an elastic limit of 8,000 to 12,000 pounds, ultimate strength of 15,000 to 20,000 pounds, with reduction of area of 6 to 8 per cent. A sample of this alloy tested by the Bethlehem Steel Company contained 3½ per cent of copper, no nickel, and had a tensile strength in casting of 15,000 pounds with 1 per cent extension. This test shows that buyers of commercial alloys should require a guarantee as to composition, as well as mechanical properties.

The alloying of pure nickel with aluminium is not an easy matter, and is best accomplished by adding nickel oxide to the bath in which aluminium is being manufactured or by reducing nickel oxide by an excess of aluminium itself, and thus obtaining a rich alloy of the two metals, from which the alloys with lower proportions of nickel can be manufactured.

ALLOYS WITH TUNGSTEN.

The precise effects of tungsten alone have not been very satisfactorily determined, since it is used in small amounts in conjunction with other hardeners of aluminium, such as with copper and iron, or copper and manganese, etc. Le Verrier gives the properties of the alloy with 7.5 per cent of tungsten as being:

	Tensile strength. (Pounds per square inch.)	Elongation. (Per cent.)
Cast	22,000	1.5
Rolled hard	35,000	4.0
Annealed	25,000	10.0

Such an alloy would be difficult to make, expensive, and not worth, mechanically, its increased cost.

Mannesmann, in making aluminium tubes, found that a fraction of 1 per cent of tungsten made the metal stronger and increased its resistance to corrosion. Under the trade name of wolfram aluminium, aluminium alloy with a small amount of tungsten has been used extensively in military experiments, the metal rolling, drawing, and spinning well without tearing or smearing the tools.

These alloys were made by adding tungstate of soda or tungstic oxide to the reducing bath in the manufacture of aluminium. At present metallic tungsten in powder, made by the Goldschmidt process, is available for alloying, and the alloys can be made directly. In this way several special alloys have been manufactured and have attained to somewhat extensive use in Europe.

Wolframium contains, according to an analysis by Minet, 98.04 per cent aluminium, 0.375 copper, 0.105 tin, 1.442 antimony, and only 0.038 tungsten. It is therefore principally an antimony alloy, the antimony giving it good casting qualities, while copper gives strength and the tin fusibility. It is difficult to see that any of its qualities could be influenced by so small a content of tungsten. The inventors (Reinhard and Roman) state in a very general way that manganese or nickel may replace more or less of the copper, tin, or antimony. Its color is like silver, it polishes finely, its resistance to corrosion is said to equal that of pure aluminium, it casts well in sand or chills, and rolls, draws, and works well generally. Its mechanical properties are stated to be:

	Tensile strength. (Pounds per square inch.)	Elongation. (Per cent.)
Hard rolled	52,000	2.14
Annealed	38,000	15.24

As this is a patented alloy the above claims of the inventors may be taken *cum grano salis*.

Partinium, the invention of G. H. Partin, of Paris, contains 96 per cent aluminium, 2.4 antimony, 0.8 tungsten, 0.64 copper, 0.16 tin. It is therefore much more of a tungsten alloy than the so-called wolframium. The inventor states, however, that the tungsten and antimony may be replaced in the alloy by magnesium, which would be an entire transposition of the composition of the alloy. Quite an extensive and noteworthy display of this alloy was made at the Paris Exposition of 1900, and it is quite possible that it is still in extensive use in France, particularly in the manufacture of automobile equipment.

ALLOYS WITH COPPER.

Copper is one of the most frequently used hardening agents for aluminium, being often used alone and often associated with zinc, nickel, and other metals. Captain Julien, making experiments for materials suitable for airships at the Park of Meudon, near Paris, obtained the following tests on sheets 1 mm. thick, hard rolled:

Per cent of copper.	Specific gravity.	Tensile strength. (Pounds per square inch.)
0	2.67	26,500
2	2.71	43,500
4	2.77	44,000
6	2.82	55,000
8	2.84	56,000

In castings these copper alloys are only slightly stronger than pure aluminium, because of the segregation of the alloy, which takes place during slow cooling. It is only in chill castings that satisfactory results can be obtained. Slabs and bars for rolling or drawing should be cast in chill molds.

German silver contains approximately 1 part zinc, 1 part nickel and 3 parts of copper. Two to 3 per cent of German silver alloyed with aluminium gives an alloy of approximately ½ per cent each of nickel and zinc and 1 to 2 per cent copper. Such an alloy gives a tensile strength in castings of 22,000 pounds and in hard rolled sheet of over 40,000 pounds, with 3 to 5 per cent elongation. This alloy, first described by the writer, is very elastic and of a fine white color, and is easily made by using commercial German silver, which contains the copper, zinc and nickel already perfectly alloyed with each other.

ALLOYS WITH MAGNESIUM.

The following tests are furnished by the Magnalium Gesellschaft of Berlin, as representing the properties of these alloys:

Per cent magnesium in alloy.	Tensile strength. (Pounds per square inch.)	Elongation. (Percentage.)
Two per cent:		
Cast in sand	17,900	3.0
Cast in chills	28,600	2.0
Castings, water chilled	40,000	1.0
Annealed sheet	25,600	18.0
Hard sheet	41,300	2.7
Four per cent:		
Cast in chills	28,600	2.0
Annealed sheet	28,700	8.0
Hard sheet	44,900	2.1
Six per cent:		
Castings, water chilled	57,600	1.0
Annealed sheet	28,100	17.0
Hard sheet	44,100	1.0
Eight per cent:		
Castings, water chilled	54,900	1.6
Ten per cent:		
Cast in sand	21,400	2.4
Cast in chills	33,600	3.4
Castings, water chilled	61,100	4.2

These alloys have been patented by L. Mach. They cost considerably more than pure aluminium, because of the market price of magnesium being in Germany $1 per pound. The use of these alloys in Europe is reported to be already considerable and to be increasing. No data regarding their durability is yet at hand.

ALLOYS WITH ZINC.

Zinc is the cheapest and at the same time one of the most efficient of the metals which improve the mechanical properties of aluminium. Proportions up to 33 per cent are used: the alloys are malleable up to 15 per cent and above that are still useful for making castings. Only the purest aluminium should be used, to get the best alloys. Casting in chills gives much better results than casting in sand; in the latter case the slow cooling seems to cause a separation.

The alloys are made by melting first all the aluminium to be used in a clean graphite crucible, bringing it a little above the melting point so that as the zinc is added, in small pieces, it does not chill the aluminium, but is all absorbed directly as it is added. The melting point decreases as zinc is added, so that if the zinc is added slowly the alloy remains always melted. A wrought-iron rod can be used as a stirrer, if the heat does not at any time go above low redness. The metal should be poured as cold as is practicable; when much hotter than its melting point it is not so thinly fluid as when somewhat cooler. The crucible should be kept covered while melting the aluminium, and no charcoal or flux put into the crucible, except possibly a little salt.

The alloy with 16 per cent zinc can be rolled and drawn. In chill castings it has an elastic limit of 16,000 pounds per square inch, a tensile strength of 22,330 pounds, an elongation of 6 per cent in 2 inches and reduction of area of 10½ per cent.

The alloy with 25 per cent zinc has a tensile strength of 22,000 pounds, extension 1 per cent and reduction of area 3 per cent, when cast in sand. When cast in chill molds its tensile strength is 35,000 to 45,000 pounds, extension 1 per cent, with a close fracture like high carbon steel. Its specific gravity is 3.4, which shows a contraction of 14 per cent in the bulk of the constituents while alloying, and since one part of zinc has only one-eighth the volume of three parts of aluminium, the remarkable conclusion follows that the aluminium takes up one-third of its weight of zinc and actually decreases in volume some 2 per cent in doing it. This probably accounts for the close grain and good working qualities of this alloy. It is non-magnetic, has a fine color, takes a high polish, and bids fair to be the most generally useful of all the light aluminium alloys.

The alloy with 33 per cent of zinc, sometimes called the Sibley casting alloy because first made in the Sibley Laboratory at Cornell University, is extremely rigid, very slightly elastic, and breaks short like cast iron, with a fine grained fracture. It is not so resistant to shock as the alloy containing less zinc. Its specific gravity is only 3.8 and its volume is only 1.5 per cent greater than the aluminium from which it is made. Its tensile strength is 24,000 pounds in sand castings and up to 40,000 pounds in chill castings, with no perceptible elongation or contraction of area. It works well, without requiring lubrication of the cutting tools. The large proportion of zinc in it makes it the cheapest of all the light aluminium alloys.

Besides these alloys with zinc alone, several casting alloys have been made containing both zinc and copper. Considerable amounts of alloys with 5 per cent copper and 15 per cent zinc and as high as 27 per cent zinc and 3 per cent copper have been made and used commercially. When cast under pressure they are stronger.

A commercial casting alloy being sold at present contains 15 per cent of zinc and 5 per cent of other hardeners—viz., 2 per cent tin, 2 per cent copper, and half of 1 per cent each of iron and manganese. It is recommended as making sharp, hard, strong castings.

CONCLUSION.

According to the claims made, the magnesium alloys are the best all around of the light aluminium alloys, but they are expensive; the zinc alloys are the cheapest to make, and are equal in mechanical properties to very nearly the best alloys made with more expensive metals, and therefore promise to have, of all the light aluminium alloys, the largest sphere of usefulness.

TREATMENT OF FINELY DIVIDED IRON ORE.*

THE introduction of magnetic enrichment and other separating processes have considerably increased the proportion of fine iron ores. The advantage of these preliminary operations is in large part counterbalanced by the inconveniences which metallurgists meet in the employment of so fine an ore powder and at times by a more difficult treatment than with a rock ore of lower percentage.

Attempts have been made to employ the fine ore directly in the blast-furnace, but the proportion of the charge depends both on the conditions of heating and on the operation of the furnace and cannot be very large; for, in this state, the ore, especially if it is of great density, as, for example, pulverized magnetite, tends to cover the combustible and to fall into the pipes imperfectly reduced, occasioning clogging and adhesion to the walls of the furnace above the crucible, and often accumulating in large masses. These, by their fall into the crucible when they are detached by the pressure of the column of material above them, meet a quantity of combustible insufficient to secure complete reduction, which has the effect of producing "cold blast pig." If the formation of scale takes place rather with the fine than with the rock ore, rather with that of feeble density than with that of high density; rather with that which contains fusible elements than with that having numerous elements of refractory character; account must also be had of the greater or less inclination of the boshes, and of the more or less refractory character of the bricks with which the interior of the furnace is lined.

In the fusion of enriched and heavy ores the combustible may be employed in smaller pieces than when the charge is of finer ore and of less density, such as limonite, "purple ore," etc.

The fine, rich and heavy ores have been employed without inconvenience in different blast furnaces at the Hogfors works, where the poor Norburg ores are enriched by washing processes. These are introduced in the furnaces in the proportion of 30 per cent, and at the Bayga blast furnaces the charge is 25 per cent of an ore obtained by magnetic separation with the Grandal sorters.

In Germany they melt the ores, which frequently are in a state of very great division; more than a quarter of the ores consumed in the German furnaces are in pieces smaller than the size of a pea, and sometimes in the form of dust. In this case it is necessary to employ blast furnaces of average height and of a comparatively low pressure of the air. In America large quantities of finely divided ore are melted, even in rapid working. Certain ores, like those which are pulverized for the purpose of concentration by washing or with magnetic sorters, are in the state of extremely fine powder, and we are assured that in the Edgar Thomson metallurgic establishments much better results have been obtained by making use exclusively of the fine in place of the rock ore. Moffert gives as the result of his experience that with the concentrated ores of Lake Champlain, which all pass through the meshes of a sieve of 0.006 millimeters, and often those still finer, no inconvenience is experienced with a charge of 50 per cent. M. Wyborg considers that this proportion may be exceeded if blast pipes at 83 to 84 deg. C. are made use of.

Outside of the inconveniences already noted, the loss of the fine ore must be added, which is drawn by the smoke in the gases, of which the effect is quite prejudicial, in consequence of the resistance which the ore offers to the gaseous current, of which it slackens the speed. In the Vidlitz blast furnaces, with charges consisting of ore concentrated magnetically, and of limonite, 8 to 10 per cent of this powdered ore is drawn off in the gas pipes.

The great disadvantage resulting from the employment of fine ore in blast furnaces is the reason why the direct manufacture with the Catalan oven, the low-hearth oven, and other processes, such as fusion in the Martin-Siemens oven and the reduction in the Wyborg oven, are still followed in countries where very finely divided ores have to be reduced. It is only in small quantities that such an ore can be treated rapidly. In certain cases, after roasting, the ores are screened with inclined sieves, so as to separate the finer particles, which are either treated separately or rejected. The resulting loss is largely compensated by the regularity thus obtained for the working of the furnace.

However, the agglomeration of the ore before fusion in the blast furnace seems to have afforded certain results, notably in the utilization of the "purple ore," the residue proceeding from the extraction of the sulphur and the copper of the Spanish pyrites, and consisting of ferric oxide in the form of a very fine powder comparatively homogeneous. The agglomeration of the ore may be effected by the action of heat alone in the reverberatory furnace, but the results are advantageous only in the case of ores particularly rich (50 or 60 per cent of iron), and containing silicates readily fusible, such as hornblende and pyroxenic ores, which it is sufficient to heat just enough to produce a commencement of fusion; but with ores enriched by concentration, it is necessary to mix them with an agglomerant, for example, fusible slag proceeding from the blast furnace, as is practised at the Cornelia mines at Stolberg and at Valimaki in Finland. There is thus the advantage of having at disposal an ore quite coherent, and at the same time fusible of itself. Water is added to the pulverulent

* From the French of Prof. Léonce Fabre of the Chemical Industrial School of Engineers at Marseilles in the Revue de Chimie Industrielle.

ore, which is cast into bricks; these in the dry state are sufficiently solid for the charge in kilns, and furnish, after roasting, pieces quite resistant. At Vidlitz, with ores in very fine powder having a maximum proportion of 50 or 60 per cent of iron, the remainder consisting of fusible silicates, the mixture is cast in small cylinders, which are roasted with coal dust in a Schedinska kiln, generally employed in that country.

With "purple ore" an ore can be obtained melting very well in the furnace by mixing equal parts of Cleveland slag and "purple ore," of which the following are analyses:

	Cleveland Slag.	Mixture.
Silica	27.6	14.0
Alumina	22.2	11.0
Lime	40.1	20.0
Magnesia	7.6	3.8
Ferric oxide	....	49.0
Other elements	2.5	2.2

Such a process is, of course, costly, in consequence of the higher temperature to be reached, and of the time lost in securing it.

Caustic or quick lime, tempered with water so as to form a consistent paste, is the best agglomerant for fine ores, especially for those containing a marked proportion of silicates or of silica. The briquettes thus made harden by continuous exposure to the air, in consequence of the conversion of the calcium oxide into carbonate, and afterward into silicate; the intimate mixture of this reducing and fusible element in the mass facilitates treatment in the blast furnace. It is for this reason that in the treatment of silicates quite differently reducible, such as the slag of reheating furnaces, these are reduced to powder and mixed with lime and wood charcoal in powder, in the form of briquettes, for the purpose of producing a slag suitable for fusion in the blast furnace.

If tar, pitch, or bituminous coal is mixed with ore, and the mixture heated strongly, after cooling compact and resisting masses will be obtained. It is thus that Weissmann operates for producing what he calls coke-ore, which is obtained by mixing fine ore with 20 per cent of coal dust and 5 per cent of pitch. The mixture is compressed in order to convert it into briquettes, which are coked at a very high temperature, produced gradually and very slowly. In this way, on the advice of M. C. Ericsson, M. Delerus, at the coke factories of Iceland, obtains with magnetite enriched magnetically at Lulea, excellent results. The ore in grains of 1 millimeter and containing 70 per cent of iron mixed with 30 to 40 per cent, yields a hard and compact product, which, after being coked, can be quenched with water like coke of good quality. By the coking the ore is reduced to ferrous oxide, with some particles of metallic iron, and does not pass to a higher state of oxidation, even by long exposure to the air.

With ores easily fusible, it is probable that this operation would result in the formation of a large quantity of metallic iron, which would be rapidly oxidized if it were sprinkled with water, or exposed for a long time to the air, diminishing thus the resistance of the coke.

As has been seen, the principal processes now followed, except on a small scale, are those in which the agglomeration of the ore is produced with lime or coal tar, and the subsequent conversion into briquettes. For the same purpose clay has also been employed.

Still, it is to be remarked that no uniform method has been adopted for the preparation of extremely fine ores of iron, and that their treatment varies, according to their character and the conditions of the country.

HOW WOVEN HOSE IS MADE.*

By DAY ALLEN WILLEY.

ALTHOUGH the first hose used for quenching fires is believed to have been made at Amsterdam in 1690, the hose which is used by the principal fire departments of the country to-day was designed but a few years ago. Until 1859 leather was the principal material used, and within recent years fire departments in some of the small towns have been equipped with it. This grade was made from strips of leather, either sewed together with hemp or fastened with copper rivets, the strips being joined in a spiral form. The beginning of the revolution in hose-making dates back to 1859, when the first manufactured from cotton, with rubber lining, was exhibited at a firemen's parade at Manchester, N. H., but rubber fire hose, as it was termed, had already been manufactured soon after Goodyear's discovery of the practical plan for vulcanizing rubber in 1844. The cotton hose, however, was more popular for the reason that it was not only lighter, but stronger. It was manufactured by weaving the material into a belt, and coating one side with rubber. The belt was then turned over a mandrel, and the edges riveted also with copper.

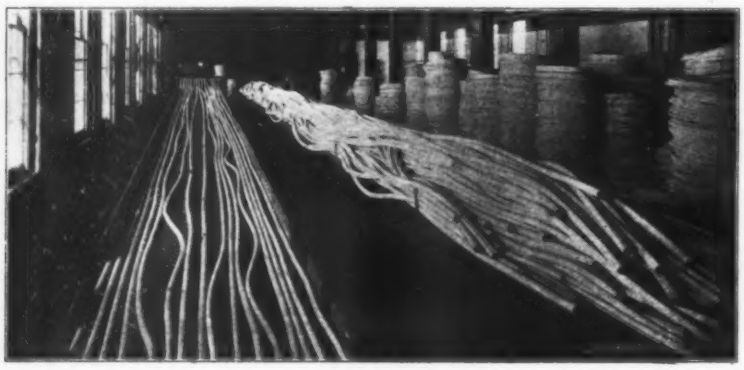
Until 1875 the hose was woven upon flat looms. During this year Mr. B. L. Stowe, of Jersey City, vice-president of the Eureka Fire Hose Company, perfected a circular loom upon which he had been working, to avoid the necessity for riveting, producing the hose in a seamless cylinder. Since the date mentioned seamless hose has been adopted by practically all of the fire departments of the United States, although a number of improvements have been made to it since the first was woven.

In spite of the strength required for fire hose, by reason of the water pressure developed by the modern steam fire pump or engine, the process of manufacturing it is comparatively simple. The cotton yarn which forms the bulk of the material is carefully selected, being at least 13 per cent above what is known as the Draper standard, probably the highest in the United States. The yarn comes to the factory in the single form, being twisted into the various plies required. The material is then served to the looms, each of which is managed by an individual operator, who is responsible for the work it performs. The fabric is woven to the length and thickness required, the heavier grades being used for suction hose for fire engines, for fireboats, and for water towers. The large sizes carry streams of water ranging from three to six inches in diameter, two and two and one-half inch hose being the usual sizes preferred in the ordinary fire service for distribution of the water. The best grade of hose contains three distinct fabrics, each having its individual series of warp and weft, so that the structure is really composed of three parts, but all are bound together in a solid fabric by binder threads common to all the plies. This work is done by the modern circular loom so thoroughly that the wall of the hose is uniform in tension and thickness throughout, while it is practically impervious to dirt. Consequently, if by accident the outer fabric should be torn away, two thicknesses remain, in addition to the rubber lining. Smaller sizes are woven with two and merely one fabric, to be used in connection with pumps in factories and other buildings, and where the pressure is not so great as in the ordinary city service, but the principle of manufacture is the same throughout. The ordinary hose used for distribution varies in weight from 48 to 60 pounds per length of 50 feet, the hose used for suction, fireboat, and water tower being, of course, heavier in proportion.

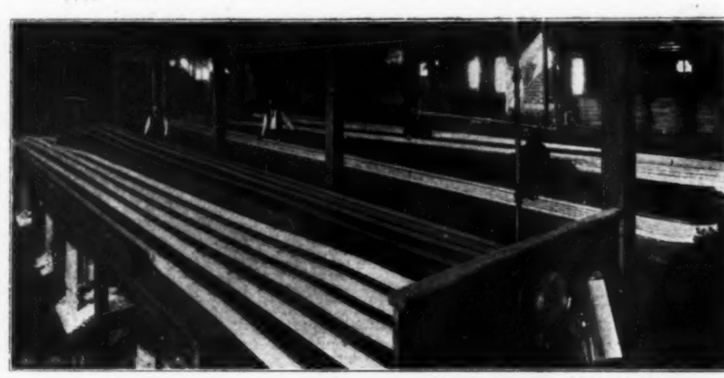
One of the most interesting features of hose manufacture is the method of lining it with rubber. This operation is performed entirely by machinery. Usually the lining consists of three parts, the rubber compound being passed through calender rolls, which are adjusted to one-third of the thickness desired. Upon the first sheet is pressed a second of similar thickness, then a third. It is next carried automatically to a table, where the width required is cut and the edges of the tube lapped and cemented together. The lining is then vulcanized in the usual manner. By some processes the tubes are finished without a seam, being manufactured entirely from one thickness, but it is claimed that the lap-joint process, as it is termed, is superior for the reason that any defect in the rubber can be detected more easily than where the material is not pressed together in sections. Before inserting in the walls of the hose, the lining tube is carefully brushed and cleaned to remove any foreign substance which may have adhered to it. It is then attached to a cylinder, which is forced through the tube by power, pulling the lining with it, after which one end of the section is attached to a steam head, the other being fastened to an exhaust head. These heads are located at each end of what is called a steam table, upon which the hose is stretched. Live steam is then turned into the hose, inflating the lining, so that it presses against the interior surface of the fabric. The steam heat at the same time softens an adhesive cement with which the outer surface of the lining has been coated, and thus attaches it to the interior of the fabric. While the hose is under pressure it is carefully examined for any possible puncture or other imperfection. A unique feature of the process is the insertion of colored threads between the fabric and rubber lining, which serve as date marks, so that after the hose has been in service, should it be returned for any reason to the factory, the color of the thread will indicate the date when it was manufactured.

It might also be added that some of the modern fire hose is not only used for carrying water, but is made a conduit for electric signal wires, so that the fireman who holds the nozzle can be in communication with the captain or other officer who may be at the other end of the hose. The wiring is passed also between the rubber lining and hose, being insulated in such a way that it does not affect the material, while the wire itself is entirely protected.

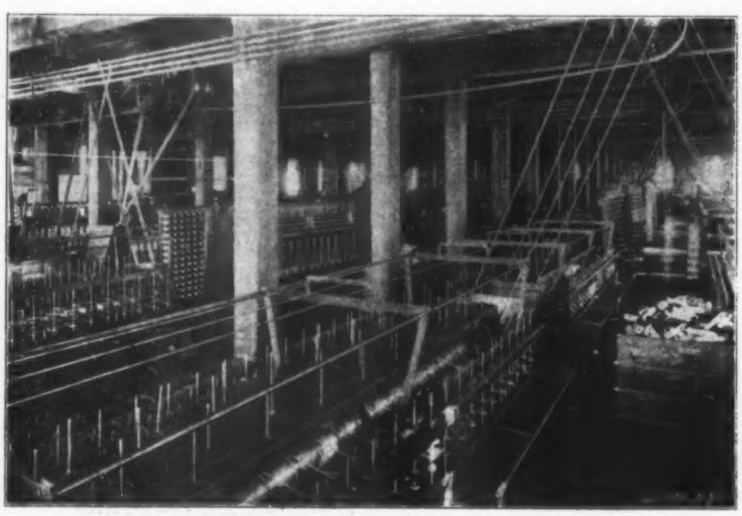
The finishing processes consist of attaching the couplings of the hose lengths, then giving the hose a



DRAWING THE RUBBER LINING INTO SMALL HOSE AND TESTING IT BY STEAM PRESSURE. TESTING-TABLE TO THE LEFT.



LINING ROOM FOR LARGE HOSE AND FOR PRELIMINARY TESTS.



SPINDLES FOR TWISTING THE YARN OF A HOSE FABRIC.

TEST OF HOSE, WITH COUPLINGS ATTACHED.

HOW WOVEN HOSE IS MADE.

* Specially prepared for the SCIENTIFIC AMERICAN SUPPLEMENT.

final test. The lengths are taken to the testing table and subjected to steam pressure according to the service required. The brands used for water distribution are usually tested up to 200 pounds at least, but some of the hose which is now made in this country will withstand a pressure of 700 pounds, so substantially is it manufactured.

One of the great difficulties which manufacturers of fire hose have encountered is its liability to mildew and be injured in other ways by the exposure and rough treatment which it receives. One method of preventing mildewing and decay of the fabric is to apply a compound of gum and wax. The objection to this, however, is that it increases the weight of the hose. Recently a chemical antiseptic treatment has been used, which effectually prevents mildewing and acts as a preservative for the fabric, while it does not increase the weight of the hose.

THE LACTO-VISCOMETER.

THE question of milk is one that interests all hygienists. What is sold to us under the name of milk? In some recent researches we have, as a general thing, met with watered and skimmed milk only. Now, it is the cream especially that gives milk its nutritive value, and it is by skimming the latter that it is removed therefrom. Watering is done in the proportion of from 15 to 40 per cent. We even meet with milk that is scarcely comparable to anything but water sweetened with 4 per cent of sugar. And with what kind of water is milk diluted? Herein lies the great danger. The first water that comes to hand is employed, since anything is good enough to answer the purposes of fraud. And such water may, and often does, contain pathogenic microbes. Besides, the diluting is often done, too, with well water, or water containing a slight percentage of sulphates. Now, the latter have a tendency to make the milk turn, and to precipitate its caseine in very fine flocks. The liquid becomes difficult of digestion, and the children to whom it is given become afflicted with gastro-enteritis. With rare exceptions, the milk that is sold to us is death to young children, and yet we hear every day about depopulation. Nearly 150,000 new-born babies die annually in France, and in most cases for want of proper food. If we prevent infantile mortality, we shall gain thousands of children out of whom to make soldiers in the future. Even in the rural districts about a quarter of the children born die before reaching the age of one year. The causes of such mortality are evidently complex; but it may be said that the prime origin of the trouble is to be found in poor alimentation—in the use of insufficient or contaminated milk. The depopulation is due in large proportion to the dairyman. Countries provided with poor milk become visibly depopulated. For example, the infantile mortality is 60 per cent greater at Hanover than at Washington, and yet these two cities are situated under equally satisfactory hygienic conditions. But at Washington severe preventive measures are taken in the sale of milk, while at Hanover there exists neither any regulation nor inspection of milk. Dr. Berliner, after a long examination, is able to explain the fact only by the difference relative to the sale and inspection of milk in the German and the American city.

At Paris, whatever may be done, the fraud takes place on a great scale, and it seems to be impossible to combat it. The consumer, much too indifferent in such matters, ought to do his own police duty. The day on which he refuses the mixture of water and milk sold to him at from 3 to 5 cents a quart, it will be necessary for the producer to change his habits. Milk or nothing! As soon as the purchaser goes seriously on a strike, everything will change.

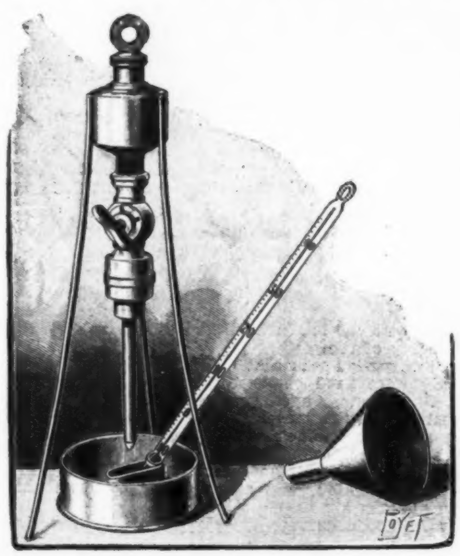
But the consumer no longer knows what good milk is, since he has lost the taste of it. And how shall it be known whether milk is good or bad? The problem is, in fact, difficult, very difficult to solve. The producer, who fears administrative severity, arranges things in such a way as to select his cows and make them give a very large quantity of milk to the detriment of its richness in butter and caseine. Such milk is naturally watery and contains but little cream. It has not been adulterated, however. In order to get around the difficulty, it would suffice to pay for the milk in proportion to its richness. It is clear that the producer would no longer obtain any advantage from diluting it, either naturally or artificially. However, it is possible to distinguish skimmed from good milk. We possess a very simple process of differentiation. But the public, again, would find it to its advantage to defend itself by giving up every dairyman who furnishes watered or skimmed milk. Is it possible to ascertain whether milk has been adulterated? This, evidently, is a question that interests every consumer.

Aside from chemical analysis, which is long and difficult, the processes used up to the present are quite inadequate. Without passing them in review in these few lines, it may be said that the most widely used instrument of control, the milk-poise or lactometer, is a deceptive one, which leads the public into error, and serves the dairyman before all else in his operations of watering and skimming. He removes some cream and the instrument indicates a milk of too great a density; so he waters it and thus diminishes its density until the liquid resumes the density characteristic of rich milk. And the trick is played to the detriment of the public.

In recent times, considerable has been said about an original method, styled the "cryoscopy of milk." The principle of this was made known by a M. Winter as long ago as 1895. Pure milk congeals at a temperature of about zero and becomes fixed, and milk skimmed or watered congeals at another temperature. Then, with a thermometer plunged into the milk surrounded with ice it is possible to deduce the degree of congelation and, consequently, the quality of the milk. This delicate method, which is based upon but very slightly marked thermometric variations, is not adapted for the use of the public.

Fortunately, we now have something that seems to solve the problem. In 1902 the Echo de Paris conceived the excellent idea of instituting a competition in the interest of the public health with a view to the discovery of a process that should permit of quickly, and without special technical knowledge, detecting the adulteration to which milk had been subjected. The jury was composed of MM. Brouardel, Haller, Blondel, Bordas, Etard, Kaiser, and Lindet, all prominent men. Following this and another competition, one apparatus that had been remarked among all others was twice awarded a prize. Its inventor, an ingenious physicist, prefers to preserve anonymity. His lacto-viscometer, which we have tried, seems to respond perfectly to the requirements of the public, and certainly merits a mention on our part.

The molecules of a liquid displace themselves with



THE LACTO-VISCOMETER.

respect to each other according to the nature of such liquid. If they move easily, it is unnecessary to say that a liquid will flow through a capillary point by the very reason of its greater or less viscosity. Now, since every liquid has its characteristic of viscosity, it will be possible to recognize it by that very fact. It is clear that if we modify the liquid by a mixture with another or by subtraction of its constituent elements, the viscosity will change and the flow of a constant volume will require a time equally characteristic of the modified liquid. The inventor of the lacto-viscometer has recognized the fact that it would be easily possible, through such variable duration of flow, to ascertain whether a milk were pure or adulterated. The introduction of a little water into the milk produces a very perceptible difference in the viscosity and, consequently, in the duration of the flow.

The apparatus in which this principle is utilized consists simply of a small copper reservoir, tinned internally and mounted upon three legs. Into this reservoir, which is closed by a metal plug, is poured a few cubic inches of milk. From the reservoir descends a fine glass tube, protected by a metal sheath. After the milk has been poured in, the cock seen in the figure is opened. The liquid traverses the tube and escapes at the bottom into a receptacle into which a thermometer plunges. It is indispensable to note the temperature of the milk, since the viscosity greatly varies therewith. The exact duration of the flow from the opening of the cock is counted by means of a second watch. There is afterward nothing further to be done but to refer to the tables furnished with the instrument, and which at once give, for all the durations of flow, and at all temperatures, the degree of purity of the milk and its composition. The idea is a good one, and so is the arrangement. We take the milk to be examined and find that the volume introduced into the reservoir has, by the watch, flowed for 2 min. 45 sec., and that the thermometer marks 18.5 deg. We find in the table: butter 3.39 in weight in 100 parts of milk, at a density of 1,032, with the notation "pretty good." The test is easy and requires but little time. It is possible, moreover, by a very simple calculation, to obtain in the same way the richness of the milk in extractive matters—lactose, caseine, salts, etc., and the probable quantity of water added. Here, then, we are provided with an instrument that reveals the quality of milk, and that any one can use without preliminary practice. It tells at once whether a milk is good, bad, passable, etc. This is a result that had not hitherto been obtained. The lacto-viscometer, therefore, affords a practical method of testing, and the use of it will exert a salutary influence upon the deplorable adulterations that are practised at present in the dairy industry.—Translated from La Nature for the SCIENTIFIC AMERICAN SUPPLEMENT.

THE COLUMBARIUM OF THE VIGNA CODINI, ROME.

THE name columbarium comes from the Latin *columba*, a dove-cote, from its resemblance to one of them. A columbarium is a sepulchral chamber provided with a considerable number of niches to receive the cinerary urns of marble or terra-cotta. The plan was a most admirable one from every point of view, and has been adopted at most crematories. The *ustonia*, or places for incinerating the bodies, were usually in the columbaria. The very wealthy had tombs of their own, but they often built these chambers for the use of their dependents. One of the most famous is that of the Vigna Codini, in the Licinian Gardens at Rome, and we have chosen this one for illustration.

This columbarium belonged to the freedmen and servants of the sons of Nero Drusus, Sr., brother of Tiberius, at the beginning of the Christian era. It was found toward the middle of the fifteenth century. It was barbarously treated, and most of the eighty-six inscriptions have perished. Our modern term "pigeonholes," is supposed to be derived from one of these mortuary chambers.

ON THE INTENSELY PENETRATING RAYS OF RADIUM.*

By Hon. R. J. STRUTT, Fellow of Trinity College, Cambridge.

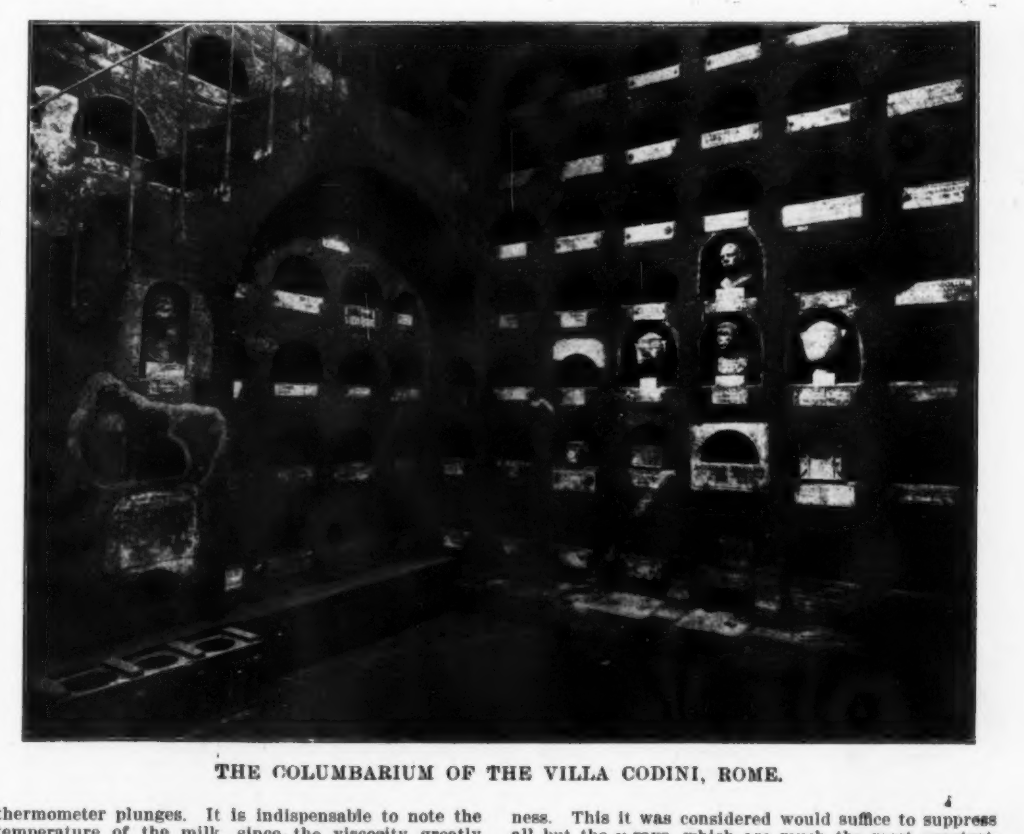
RADIUM is known to emit three types of radiation. These are:

1. The α-rays, very easily absorbed by solids, and carrying a positive electric charge.
2. The β-rays, more penetrating than these, and negatively charged.
3. The γ-rays, intensely penetrating, and not conveying an electric charge at all.

In a paper published in the Phil. Trans. for 1901, I investigated the relative ionizations of gases by the α- and β-rays. The present communication may be regarded as a sequel to that one, and deals with the γ-rays.

The radium employed was of activity 1,000 (uranium = 1), and was contained in a glass cell, over which was cemented a piece of thin aluminium. The cell was placed in a cavity in a block of lead, and over it was placed a disk of lead 1 centimeter in thickness. This it was considered would suffice to suppress all but the γ-rays, which are much the most penetrating.

In measuring the electrical leakage, the electroscope method was employed. The apparatus was that



THE COLUMBARIUM OF THE VILLA CODINI, ROME.

* A paper communicated to the Royal Society, August 5, 1903.

described in a paper published in the Philosophical Magazine for June, 1903, p. 681.

The radium, covered by the thick lead, was placed under the apparatus, and the rate of leak determined when the different gases filled the testing vessel.

The conditions were, of course, arranged so as to use a saturating E. M. F. The γ-rays are so penetrating that there can be no question of their being appreciably absorbed in a moderate thickness of gas.

For the methods of preparation of the gases I must refer to the former paper (Phil. Trans., A., 1901, vol. cxcvi., p. 508).

The results were as follows; the rates of leak are given in scale divisions per hour, and are corrected to 30 inches pressure:

Gas.	Rate of leak.	Mean.
Hydrogen	10.4 10.5, 10.4, 11.2, 10.4 11.2, 9.86, 10.1, 10.2	10.5
Air	65.2, 66.6, 66.6, 60.0, 57.0 61.5, 60.2, 63.0, 58.2, 58.3, 56.6, 56.2	62.1
Oxygen	75.0, 74.2, 71.0, 74.1	73.6
Carbon dioxide	96.0, 95.4, 94.5, 95.1, 94.1, 94.7	95.0
Cyanogen	107, 104, 106, 106	106.0
Sulphur dioxide	132, 126, 134, 135	132.0
Chloroform	297, 298, 290, 327	303.0
Methyl iodide	298, 292, 310, 291	298.0
Carbon tetrachloride	363, 351, 344, 349	352.0

The following table gives the relative ionizations, referred to air as unity. The values of the same constants for the α- and β-rays formerly found are included, and also measurements of relative ionization under Röntgen rays. These latter form part of an investigation not hitherto published:

Relative Ionizations.

Gas.	Relative density.	Relative ionization.			
		α-Rays.	β-Rays.	γ-Rays.	Röntgen rays.
Hydrogen	0.0693	0.226	0.157	0.169	0.114
Air	1.00	1.00	1.00	1.00	1.00
Oxygen	1.11	1.16	1.21	1.17	1.39
Carbon dioxide	1.53	1.54	1.57	1.53	1.60
Cyanogen	1.86	1.94	1.86	1.71	1.05
Sulphur dioxide	2.19	2.04	2.31	2.13	7.97
Chloroform	4.32	4.44	4.89	4.88	31.9
Methyl iodide	5.05	3.51	5.18	4.80	72.0
Carbon tetrachloride	5.31	5.34	5.83	5.67	45.3

The determinations for the γ-rays are less accurate than the former ones for the α- and β-rays, on account of the very much smaller rates of leak which have to be measured. I think, if this be taken into account, there is no reason to doubt that, within the limits of experimental error, the γ-rays give the same values as the β-rays. These values are nearly proportional to the density of the gas, except in the case of hydrogen. The law which holds in the case of Röntgen rays is totally different.

This conclusion throws some light on the nature of the γ-rays. The view seems to be gaining ground that these are Röntgen rays, produced by the impact of the β-rays on the radium itself (see, for instance, Mdme. Curie, "Thèses presentées à la Faculté des Sciences," 1903, p. 83; Chem. News, vol. lxxxviii., p. 85 *et seq.*) This theory seems to have much to recommend it. The β rays should, by analogy with the cathode rays in a vacuum tube, produce Röntgen rays when they strike a solid obstacle, and these Röntgen rays should be much more penetrating than the β-rays themselves. The γ-rays seem at first sight to be just what should be expected. But the present paper shows that, in one respect at all events, the γ-rays behave quite differently to Röntgen rays, while, on the other hand, they resemble the α and β-rays. There seems to be a possibility that they, too, are of a corpuscular nature, though uncharged with electricity. This would account for the absence of magnetic deflection.

I do not think that the absence of conspicuous Röntgen radiation is very hard to understand, if we consider that the current emitted in cathode rays by a square inch of intensely active radium is only 10^{-11} amperes; the current through a focus tube is of the order 10^{-3} amperes, and probably a great part of this is carried by the cathode rays.

GEOGRAPHY.*

By CAPTAIN ETTRICK W. CREAK, C.B., R.N., F.R.S.

OF the six distinguished naval officers who have previously presided over this Section, four were Arctic explorers; and therefore, possessing personal experience in Arctic regions, they naturally gave prominence to the deeply interesting subject of the past and future of Arctic discovery in their addresses, while not forgetting other matters relating to the geography of the sea. The remaining officers, from their immediate connection with all that relates to the physical condition of the ocean, in its widest sense, coupled with the great importance of giving the fruits of their knowledge to the world, took that subject as their principal theme.

Valuable as are contributions to our knowledge of the physics of the ocean to the world in general, and especially to the mariner and water-borne landsman, I propose to take a different course, and bring to your notice the subject of Terrestrial Magnetism in its relation to Geography. In doing so, I shall endeavor to show that much may be done by the traveler on land and the seaman at sea in helping to fathom the mysteries connected with the behavior of the freely suspended magnetic needle, as it is carried about over that great magnet, the earth, by observations in different regions, and even in limited areas.

I would, however, pause a moment to call attention to the presence of several distinguished meteorologists at this meeting, who will surely attract many to the consideration of matters connected with the important science of meteorology, which already occupies considerable attention from travelers. I feel sure, therefore, that geographers will be glad to accord a hearty welcome to the members of the International Meteorological Congress now assembled in this town, and especially to the foreign visitors who honor us by their presence.

Someone may ask, What has Terrestrial Magnetism to do with Geography? I reply, excellent lectures on that subject of growing importance have been given under the direct auspices of the Royal Geographical Society; one in 1878 by the late Captain Sir Frederick Evans, and another in 1897 by Sir Arthur Rücker. And I would here quote the opinion of Dr. Mill when defining geography, in my support: "Geography is the science which deals with the forms of the earth's crust, and with the influence which these forms exercise on the distribution of other phenomena."

We know now that the normal distribution of the earth's magnetism for any epoch is in many localities seriously affected accordingly as the nature of the country surveyed be mountainous, or generally a plain, in the form of islands (or mountains standing out of the sea), and from land under the sea. There is also reason to suspect that the magnetism of that portion of the earth covered by the oceans differs in intensity from that of the dry land we inhabit. A connection between the disturbances of the earth's crust in earthquakes and disturbances of the magnetic needle also seems to exist, although the evidence on this point is not conclusive.

MAGNETIC SURVEYS.

Previously to the year 1880 there were two periods of exceptional activity on the part of contributors to our knowledge of the earth's magnetism, during which the scientific sailor in his ship on the trackless ocean combined with his brethren on land in making a magnetic survey of the globe.

The first period was that of 1843-49, during which not only were fixed observatories established at Toronto, St. Helena, Capetown, and Hobart for hourly observations of the movements of the magnetic needle, but, to use Sabine's words, "that great national undertaking, the magnetic survey of the south polar regions of the globe," the forerunner of our present Antarctic expedition, was accomplished by Ross and his companions almost entirely at sea.

This Antarctic survey was carried out during the years 1840-45, and the results given to the world as soon as possible by Sabine. The results afterward formed a valuable contribution when constructing his maps of equal lines of magnetic declination, inclination, and intensity for the whole world, a great work for the completion of which Sabine employed every available observation made up to the year 1870, whether on land or at sea.

Readers of these contributions cannot fail to be struck with the great number of observations made by such travelers as Hansteen and Due, Erman and Wrangel, extending from Western Europe to far into Siberia.

The second period was that of 1870-80, during which not only was there much activity among observers on land, but that expedition so fruitful to science, the voyage of H. M. S. "Challenger," took place. During the years 1872-76 we find the sailor in the "Challenger" doing most valuable work in carrying out a magnetic survey of certain portions of the great oceans, valuable not only for needful uses in making charts for the seaman, but also as a contribution to magnetic science.

Prior to this expedition very little was known from observation of the distribution of terrestrial magnetism in the central regions of the North and South Pacific oceans, and Sabine's charts are consequently defective there.

Combining the "Challenger" magnetical results with those of all available observations made by others of our ships, and by colonial and foreign governments, I was enabled to compile the charts of the magnetic elements for the epoch 1880, which were published in the report of the scientific results of H. M. S. "Challenger." I will venture to say that these charts give a fairly accurate representation of the normal distribution of the earth's magnetism between parallels of 70 deg. north and 40 deg. south. Beyond these limits, either northward or southward, there is a degree of uncertainty about the value of the lines of equal value, especially in the southern regions, an uncertainty which we have reason to hope will be dissipated when we know the full results obtained by Captain Scott and the gallant band he commands, for as yet we have to be content with some eddies of the full tide of his success.

Until the "Discovery" was built, the "Challenger" was the last vessel specially selected with the view of obtaining magnetic observations at sea, so that for several years past results obtained on land have been our mainstay. Thus, elaborate magnetic surveys with fruitful results have been carried out in recent years in the British Isles by Rücker and Thorpe. France, Germany, Holland, and some smaller districts in Europe have also been carefully surveyed, and British India partially so, by the Messrs. Schlagintweit, in 1857-58. The latter country is being again magnetically surveyed under the auspices of the Indian government.

On the American continent the Coast and Geodetic Survey of the vast territories comprised in the United States, which has been so many years in progress, has been accompanied by an extended magnetic survey during the last fifty-two years, which is now under the able direction of Dr. L. A. Bauer. Resulting from this some excellent charts of the magnetic declination in the United States have been published from time to time; and the last, for the epoch 1902, is based upon 8,000 observations.

There are other contributions to terrestrial magnetism for positions on various coasts from the surveying service of the Royal Navy, and our ships of war are constantly assisting with their quota to the magnetic declination, or variation, as sailors prefer to call it; and wisely so, I trow, for have they not the declination of the sun and other heavenly bodies constantly in use in the computation of their ship's position?

This work of the Royal Navy and the Indian Marine is one of great importance, both in the interests of practical navigation and of science; for besides the equipment of instruments for absolute determinations of the declination, dip, and horizontal force supplied to certain of our surveying-ships, every seagoing vessel in the service carries a landing compass, specially tested, by means of which the declination can be observed with considerable accuracy on land.

Although observers of many other objects may still speak of their "heritage the sea" as a mine of wealth waiting for them to explore, unfortunately for magnetic observations we can no longer say "the hollow oak our palace is," for wood has been everywhere replaced by iron or steel in our ships, to the destruction of accurate observations of dip and force on board of them. Experience, however, has shown that very useful results, as regards the declination, can be obtained every time a ship is "swung," either for that purpose alone, or in the ordinary course of ascertaining the errors of the compass due to the iron or steel of the ship.

As an example of this method, the cruise of the training squadron to Spitzbergen and Norway in 1895 may be cited, when several most useful observations were made at sea in regions but seldom visited. Again, only this year a squadron of our ships, cruising together near Madagascar, separated to a distance of a mile apart and "swung" to ascertain the declination.

I would here note that all the magnetic observations made by the officers of our ships during the years 1890-1900 have been published in a convenient form by the Hydrographic Department of the Admiralty.

The fact remains, however, that a great portion of the world, other than the coasts, continues unknown to the searching action of the magnetic needle, while the two-thirds of the globe covered by water is still worse off. Among other regions I would specify Africa, which, apart from the coasts, Cape Colony, and the Nile valley to latitude 5½ deg. north, is absolutely a new field for the observer.

Moreover, the elaborate surveys I have mentioned show how much the results depend upon the nature of the locality. I am therefore convinced that travelers on land, provided with a proper equipment of instruments for conducting a land survey of the strange countries which they may visit, and mapping the same correctly, can, with a small addition to the weight they carry, make a valuable contribution to our knowledge of terrestrial magnetism, commencing with observations at their principal stations and filling in the intermediate space with as many others as circumstances will permit.

THE ANTARCTIC EXPEDITION.

Of the magnetic work of our Antarctic expedition we know that since the "Discovery" entered the pack—and, so far as terrestrial magnetism is concerned, upon the most important part of that work—every opportunity has been seized for making observations.

Lyttleton, New Zealand (where there is now a regular fixed magnetic observatory), was made the primary southern base station of the expedition; the winter quarters of the "Discovery," the secondary southern base station. Before settling down in winter quarters, magnetic observations were made on board the ship during the cruise to and from the most easterly position attained off King Edward VII. Land in latitude 76 deg. south, longitude 152½ deg. west, and she was successfully swung off Cape Crozier to ascertain the disturbing effects of the iron upon the compasses and dip and force instruments mounted in the ship's observatory.

As a ship fitted to meet the most stormy seas and to buffet with the ice, the "Discovery" has been a great success. Let me add another tribute to her value. From Spithead until she reached New Zealand but small corrections were required for reducing the observations made on board. The experience of Ross's Antarctic expedition had, however, taught the lesson that two wood-built ships, the "Erebus" and "Terror," with but some 3 to 4 deg. deviation of the compass at Simon's Bay, South Africa, found as much as 56 deg. of deviation at their position farthest south, an amount almost prohibitory of good results being obtained on board.

How fared the "Discovery"? I have been told by Lieutenant Shackleton—for the cause of whose return to England we must all feel great sympathy—that a maximum of only 11 deg. of deviation was observed at her most southerly position. From this we may look forward hopefully to magnetic results of a value hitherto unattained in those regions.

At winter quarters, besides the monthly absolute observations of the magnetic elements, the Eschenhagen variometers of self-registering instruments for continuously recording the changes in the declination, horizontal force, and vertical force were established, and in good working order at the time appointed for commencing the year's observations.

I may here remind you that some time previously to the departure of the British and German Antarctic expeditions, a scheme of co-operation had been established between them, according to which observations of exactly the same nature, with the same form of variometers, were to be carried out at their respective winter quarters during a whole year, commencing March 1, 1902. Besides the continuous observations with the variometers, regular term-days and term-hours were agreed upon for obtaining special observations with them at the same moment of Greenwich mean time. Both expeditions have successfully completed this part of their intended work.

To co-operate in like manner with these far southern stations, the Argentine government sent a special party of observers to Staten Island, near Cape Horn, and the Germans another to Kerguelen Land, while New Zealand entered heartily into the work. In addition, similar observations were arranged to be made in certain British and colonial observatories, which include Kew, Falmouth, Bombay, Mauritius, and Melbourne; also in German and other foreign observatories.

We have all read thrilling accounts of the journeys of the several traveling parties which set out from the "Discovery," and of the imminent dangers of life they encountered and how they happily escaped them except one brave fellow named Vince, who disappeared over one of those mighty ice-cliffs, upon which all Antarctic voyagers descant, into the sea. In spite of all this there is a record of magnetic observations taken on these journeys of which only an outline has yet been given. Anticipations of the value of these

* Read before British Association for the Advancement of Science.

observations are somewhat clouded when we read in one report that hills "more inland were composed of granite rock, split and broken, as well as weatherworn, into extraordinary shapes. The lower or more outer hills consisted of quartz, etc., with basaltic dikes cutting through them." Consequently, we have to fear the effects of local magnetic disturbances of the needle in the land of observations, while buoyed up with the hope of obtaining normal results on board the ship.

Judging from some land observations which have been received, it appears that considerable changes have taken place in the values of the magnetic elements in the regions we are considering, but when making comparisons we have to remember the sixty years which have elapsed since Ross's time, and that he had nothing like the advantage of steam for his ships, or of instruments of precision like our present ship "Discovery." His ships also were, as we have already remarked, much worse magnetically, causing far more serious disturbance of the instruments. Hence the changes we note may not be entirely due to changes in the earth's magnetism.

The observations made by the officers of the "Southern Cross" at Cape Adare in 1899-1900 also contribute to this question of magnetic change.

THE MAGNETIC POLES OF THE EARTH.

I will now refer to those two areas on the globe where the dipping needle stands vertically, known as the magnetic poles. The determination of the exact position of these areas is of great importance to magnetic science, and I will just glance at what is being done to solve the problem.

Let us consider the North Pole first, the approximate position of which we know best from observation. If one were asked to say exactly where that pole has been in observation times, whether it has moved, or where it now is, the answer must be, "I do not know." It is true that Ross in 1831, by a single observation, considered he had fixed its position, and I believe hoisted the British flag over the spot, taking possession thereof; but he may or may not have set up his dip circle over a position affected by serious magnetic disturbance, and therefore we must still be doubtful of his complete success from a magnetic point of view. Although eminent mathematicians have calculated its position, and Neumayer in 1885 gave a place to it on his charts of that year, we have still to wait for observation to settle the question, for one epoch at least.

Happily, I am able to repeat the good news that the Norwegian, Capt. Roald Amundsen, sailed in June last with the express object of making a magnetic survey of Ross's position and of the surrounding regions, in order to fix the position of the north magnetic pole. Furnished with suitable instruments of the latest pattern, he proposes to continue his investigations until 1905, when we may look for his return and the fulfillment of our hopes.

So far as we can now see, the south magnetic pole cannot be approached very nearly by the traveler, and we can only lay siege to it by observing at stations some distance off but encircling it. We have our own expedition on one side of it, and now with the return of the "Gauss" to South Africa in June last, we have learned that that vessel wintered in latitude 66 deg. 2 min. south, longitude 89 deg. 48 min. east, a position on the opposite side of the supposed site of the magnetic pole to that of the "Discovery." We may now pause to record our warm congratulations to Dr. von Drygalski and his companions on their safe return, accompanied by the welcome report that their expedition has proved successful.

In addition to the British and German expeditions, there are the Swedish expedition and the Scottish expedition. Therefore, with so many nationalities working in widely different localities surrounding it, we have every reason to expect that the position of the south magnetic pole will be determined.

THE SECULAR CHANGE.

When in the year 1600 Gilbert announced to the world that the earth is a great magnet, he believed it to be a stable magnet; and it was left to Gellibrand, some thirty-four years later, by his discovery of the annual change of the magnetic declination near London, to show that this could hardly be the case. Ever since then the remarkable and unceasing changes in the magnetism of the earth have been the subject of constant observation by magneticians and of investigations by some of the ablest philosophers in Europe and America. Year after year new data are amassed as to the changes going on in the distribution of the magnetism of the earth, but as yet we have been favored by hypotheses only as to the cause of the wondrous changes which the magnetic needle records.

These hypotheses were at one time chiefly based upon a consideration of the secular change in the declination, but it is now certain that we must take into account the whole of the phenomena connected with the movements of the needle, if we are to arrive at any satisfactory result. Besides, it will not suffice to take our data solely from existing fixed observatories, however relatively well placed and equipped, and valuable as they certainly are, for it now appears that the secular change is partly dependent upon locality, and that even at places not many miles apart differences in results unaccounted for by distance have been obtained.

The tendency of observation is increasingly to show that the secular change of the magnetic elements is not a world-wide progress of the magnetic needle moving regularly in certain directions, as if solely caused by the regular rotation during a long series of years of the magnetic poles round the geographical poles, for if you examine Map No. 1, showing the results of observations during the years 1840-80 as regards secular change, you will observe that there are local causes at work in certain regions, while in others there is rest, which must largely modify the effect of any polar rotation.

Allow me to explain further. The plain lines on Map No. 1 indicate approximate regions of no secular change in the declination, and the small arrows the general direction (not the amount) in which the north-seeking end of the horizontal needle was moving during those forty years. The foci of greatest change in declination with the approximate amount of annual change in the northern hemisphere, are shown in the German Ocean and northwest Alaska, in the southern hemisphere off the coast of Brazil, and in the South Pacific between New Zealand and Cape Horn. The two foci of greatest annual change in the dip are shown one in the Gulf of Guinea where the north-seeking end of the needle was being repelled strongly upward, the other on the west side of Tierra del Fuego, where the north-seeking end of the needle was being attracted strongly downward.

It is remarkable that the lines of no change in the declination pass through the foci of greatest change in the dip. If the needle be repelled upward, as at the Gulf of Guinea focus, it will be found to be moving to the eastward on the east side of the whole line of no change in the declination from the Cape of Good Hope to Labrador; to the westward on the west side. If the needle be attracted downward, as at the Tierra del Fuego focus, it will be found moving to the westward on the east side of the whole line of no declination from that focus to near Vancouver Island; to the eastward on the west side.

A similar result may be seen in the line passing through a minor focus of the dip near Hong Kong.

Judging from analogy there should be another focus of change in the dip in latitude 70 deg. north, longitude 115 deg. east, or about the position assigned to the Siberian focus of greatest force.

On Map No. 2 are shown lines of equal value of the declination—the red lines for the year 1880, the black lines for the year 1895. From these, when shown on a large scale, we may deduce the mean annual change which has taken place in the declination during the fifteen years elapsed.

In this map we are reminded of the different results we obtain in different localities, for if a line be drawn from Wellington in New Zealand past Cape York in Australia to Hong Kong, little or no change will be found in the neighboring region since 1840. Again, the line of no change in the declination shown on Map No. 1 to be following much the same direction as the great mountain ranges on the west side of the American continent has hardly moved for many years according to the observations available.

On the other hand, let us now turn to an example of the remarkable changes which may take place in the declination unexpectedly and locally. The island of Zanzibar and the east coast of Africa were constantly being visited by our surveying ships and ships of war up to the year 1880, observations of the declination being made every year at Zanzibar during the epoch 1870-80. The results showed that from Capetown nearly to Cape Guardafui the annual change of that element hardly exceeded 1 min.

During the succeeding years of 1890-91 observations were made by the Germans at Dar-es-Salaam and some other places on the neighboring coasts, with the result that the declination was found to be changing at first 3 min. annually, and since that period it had reached 10 to 12 min. at Dar-es-Salaam. Subsequent observations at the latter place in 1896-98 confirmed the fact of the great change, and in addition our surveying-ship on the station, specially ordered to "swing" at different places in deep water off the coast, generally confirmed the results. It is remarkable that while such great changes should have taken place between Capetown and Cape Guardafui, Aden, and the region about the straits of Bab-el-Mandeb seem to be comparatively unaffected.

LOCAL MAGNETIC DISTURBANCE.

In Map No. 2 normal lines of equal value of the declination are recorded, and so far as the greater part of the globe covered by water is concerned, we may accept them as undisturbed values, for we have yet to learn that there are any local magnetic disturbances of the needle in depths beyond 100 fathoms.

When, however, we come to the land, there is an increasing difficulty in finding districts of only a few miles in extent where the observed values of the magnetic elements at different stations therein do not differ more widely than they should if we considered only their relative position on the earth as a magnet. Take Rücker and Thorpe's maps of the British Isles and those of the United States, for example, where the lines of equal value are drawn in accordance with the observations, with the result that they form extraordinary loops and curves differing largely from the normal curves of calculation.

From among numerous examples of disturbance of the declination on land, two may be quoted. In the Rapakivi district, near Wiborg, a Russian surveying officer in the year 1890 observed a disturbance of 180 deg., or, in other words, the north point of his compass pointed due south. At Invercargill, in New Zealand, within a circle of 30 feet radius, a difference of 56 deg. was found. Even on board ships in the same harbor different results are sometimes observed, as our training squadron found at Reikiavik in Iceland, and notably in our ships at Bermuda.

It is hardly necessary to add that the dip and force are often largely subject to like disturbance, but I do so in order to warn travelers and surveyors that observations in one position often convey but a partial truth; they should be supplemented by as many more as possible in the neighborhood or district. Erroneous values of the secular change have also been published from the various observers not having occupied exactly the same spot, and even varied heights of the instrument from the ground may make a serious difference, as at Rapakivi before mentioned, and at Madeira, where the officers of the "Challenger" expedition found the dip at a foot above the ground to be 48 deg. 46 min. north; at 3¼ feet above the ground 56 deg. 18 min. north at the same spot.

All mountainous districts are specially open to suspicion of magnetic disturbance, and we know from comparison with normal observations at sea that those mountains standing out of the deep sea, which we call islands, are considerably so affected.

MAGNETIC SHOALS.

The idea that the compasses of ships could be affected by the attraction of the neighboring dry land, causing those ships to be unsuspectingly diverted from their correct course, was long a favorite theory of those who discussed the causes of shipwreck, but it was "a fond thing vainly invented." I can hardly say this idea is yet exploded, but from what has already been said about local magnetic disturbance on land, it is not a matter of surprise that similar sources of disturbance should exist in the land under the sea, for it has been found that in certain localities, in depths of water sufficient to float the largest ironclad, considerable disturbances are caused in the compasses of ships.

An area of remarkable disturbance having been reported as existing off Cossack, northwest Australia, H. M. S. "Penguin," a surveying ship provided with the necessary magnetic instruments, was sent by the Admiralty in 1891 to make a complete magnetic survey of the locality, with a view to ascertain the facts and place them on a scientific basis. An area of disturbance 3.5 miles long by 2 miles broad, with not less than 8 fathoms of water over it, was found lying in a northeast by east and southwest by west direction. At one position the disturbing force was sufficient to deflect the "Penguin's" compass 56 deg.; in another—the focus of principal disturbance—the dip on board was increased by 29 deg., and this at a distance of more than 2 miles from the nearest visible land, upon which only a small disturbance of the dip was found.

This remarkable area of disturbance was then called a "magnetic shoal," a term which at first sight hardly appears to be applicable. We have, however, become familiar with the terms "ridge line, valley line, peak, and col," as applied to areas of magnetic disturbance on land; therefore I think we may conveniently designate areas of magnetic disturbance in land under the sea "magnetic shoals."

This year the surveying ship "Research" has examined and placed a magnetic shoal in East Loch Roag (Island of Lewis), but as all our surveying-ships are practically iron ships, it was impossible from observations on board to obtain the exact values of the disturbing forces prevailing in this shoal. The reason for this is that, although we may accurately measure the disturbing forces of the iron of the ship in deep water, directly she is placed over the shoal induction takes place, and we can no longer determine to what extent the observed disturbances are due to the ship's newly developed magnetism, or to what extent the shoal alone produces them.

We can, nevertheless, even in an iron ship, accurately place and show the dimensions of a magnetic shoal and the direction in which a ship's compass will be deflected in any part of it by compass observations only. Is it not, therefore, the duty of any ship meeting with such shoals to stop and fix their position?

The general law governing the distribution of magnetism on these magnetic shoals is that in the northern hemisphere the north point of the compass is drawn toward the focus of greatest dip; in the southern hemisphere it is repelled. The results at East Loch Roag proved an exception, the north point of the compass being repelled.

TERRESTRIAL MAGNETISM AND GEOLOGY.

I have already referred to the question of local magnetic disturbance as one of great importance in magnetic surveys. The causes of these disturbances were at one time a matter of opinion, but the evidence of the elaborate magnetic surveys I have alluded to, when compared with the geological maps of the same countries, points clearly to magnetic rocks as their chief origin.

Magnetic rocks may be present, but from their peculiar position fail to disturb the needle; but, on the other hand, as Rücker writes in his summary of the results of the great magnetic survey of the British Isles conducted by Thorpe and himself, "the magnet would be capable of detecting large masses of magnetic rock at a depth of several miles," a distance not yet attained by the science of the geologist.

Again, Dr. Rijckevorsel, in his survey of Holland for the epoch 1891, was convinced that "in some cases, in many perhaps, there must be a direct relation between geology and terrestrial magnetism, and that many of the magnetic features must be in some way determined by the geological structure of the underground.

During the years 1897-99 a magnetic survey was made of the Kaiser-stuhl, a mountainous district in the neighborhood of Freiburg, in Baden, by Dr. G. Meyer. Exact topographical and geological surveys had been previously made, and the object of the magnetic survey was to show how far the magnetic disturbances of the needle were connected with geological conformations. Here, again, it was found that the magnetic and geological features of the district showed considerable agreement, basaltic rocks being the origin of the disturbance. This was not all, for in the level country adjacent to the Rhine and near Breisach unsuspected masses of basalt were found by the agency of the magnetic needle.

More recently we find our naval officers in H. M. S. "Penguin," with a complete outfit of magnetic instruments, making a magnetic survey of Funafuti atoll and assisting the geologist by pointing out, by means of the observed disturbance of the needle, the probable positions in the lagoon in which rock would be most accessible to their boring apparatus.

Leaving the geologist and the magnetician to work in harmony for their common weal, let us turn to some other aspects of the good work already accomplished and to be accomplished by magnetic observers.

MAGNETIC CHARTS.

Of the valuable work of the several fixed magnetic observatories of the world, I may remark that they are constantly recording the never-ceasing movements of the needle, the key to many mysteries to science existing in the world and external to it, but of which we have not yet learned the use. Unfortunately many of these once fixed observatories have become travelers to positions where the earth can carry on its work on the needle undisturbed by electric trams and railways which have sprung up near them, and it is to be hoped they will find rest there for many years to come.

Of the forty-two observatories which publish the values of the magnetic elements obtained there, thirty-two are situated northward of the parallel of 30 deg.

north, and only four in south latitude; and it is a grief to magneticians that so important a position as Capetown or its neighborhood does not make an additional fixed magnetic observatory of the first order.

Thus, so far as our present question of magnetic charts and their compilation is concerned, the observatories do not contribute largely, but we should be very grateful to them for the accurate observations of the secular change they provide which are so difficult to obtain elsewhere.

Of the value of magnetic charts for different epochs I have much to say, as they are required for purely scientific inquiry as well as for practical uses. It is only by their means that we can really compare the enormous changes which take place in the magnetism of the globe as a whole; they are useful to the miner, but considerably more so to the seaman. Had it not been for the charts compiled from the results of the untiring labors of travelers by land and observers at sea in the field of terrestrial magnetism during the last century, not only would science have been miserably poorer, but it is not too much to say that the modern iron or steel steamship traversing the ocean on the darkest night at great speed would have been almost an impossibility, whereas with their aid the modern navigators can drive their ships at a speed of 26.5 statute miles an hour with comparative confidence, even when neither sun, moon, nor stars are appearing.

Of the large number of travelers by sea, including those who embark with the purpose of increasing our geographical knowledge of distant lands and busying themselves with most useful inquiries into the geology, botany, zoology, and meteorology of the regions they visit, few realize that when they set foot on board ship (for all ships are now constructed of iron or steel) they are living inside a magnet. Truly a magnet, having become one by the inductive action of that great parent magnet—the earth.

How fares the compass on board those magnets, the ships, that instrument so indispensable to navigation, which Victor Hugo has forcibly called "the soul of the ship," and of which it has been written,

"A rusted nail, placed near the faithful compass,
Will sway it from the truth, and wreck an argosy"?

And if so small a thing as an iron nail be a danger, what are we to say to the iron ship? Let us for a moment consider this important matter.

If the nature of the whole of the iron or steel used in construction of ships were such as to become permanently magnetic, their navigation would be much simplified, as our knowledge of terrestrial magnetism would enable us to provide correctors for any disturbing effects of such iron on the compass, which would then point correctly. But ships, taken as a whole, are generally more or less unstable magnets, and constantly subject to change, not only on change of geographical position, but also of direction of the ship's head with regard to the magnetic meridian. Thus a ship steering on an easterly course may be temporarily magnetized to a certain extent, but on reversing the ship's course to west she would after a time become temporarily magnetized to the same amount, but in the opposite direction, the north point of the compass being attracted in each case to that side of the ship which is southernmost.

Shortly, we may define the action of the earth's magnetism on the iron of a ship as follows: The earth being surrounded by a magnetic field of force differing greatly in intensity and direction in the regions from the North Pole to the equator and the equator to the South Pole, the ship's magnetic condition is largely dependent upon the direction of her head while building and the part of that field she occupied at the time; partly upon her position in the magnetic field she traverses at any given time during a voyage.

For the reasons I have given, magnetic charts are a necessity for practical purposes and in the following order of value. That of the magnetic declination or variation which is constantly in use, especially in such parts of the world as the St. Lawrence and the approaches to the English Channel, where the declination changes very rapidly as the ship proceeds on her course. Next, that of the dip and force, which are not only immediately useful when correcting the ship's compass, but are required in the analysis of a ship's magnetism both as regards present knowledge and future improvements in placing compasses on board.

If astronomers have for a very long time been able to publish for several years in advance exact data concerning the heavenly bodies, is it too much to hope that magneticians will before long also be able to publish correct magnetic charts to cover several years in advance of any present epoch? If this is to be done within reasonable time there must be a long pull, a strong pull, and a pull all together of magnetic observers in all lands, and accumulated data must also be discussed.

ON MAGNETIC INSTRUMENTS FOR TRAVELERS.

Travelers in unsurveyed countries, if properly instructed and equipped, can do good service to science by observing the three magnetic elements of declination, inclination or dip, and force at as many stations as circumstances will permit; hence the following remarks.

For the purpose of making the most exact magnetic survey the best equipment of instruments consists of the well-known unifilar magnetometer, with fittings for observing the declination, and a Barrow's dip circle. To some travelers these instruments might be found too bulky, and in some regions too delicate as well as heavy to carry.

Of suitable instruments made abroad, those used by M. Moureaux in his survey of France may be mentioned, as they are of similar type, but much smaller and lighter than the instruments above mentioned.

Another form of instrument, called an L. C. instrument, for observing both the inclination and total force, is shown in the instrument before you. Originally designed for observations on board ships at sea where the ordinary magnetic instruments are unmanageable, it has also been found to give satisfactory results in a land survey, where greater accuracy is expected than at sea. Thus, during a series of observations extending from the north side of Lake Superior to the southern part of Texas last year, comparisons were made between the results obtained with an L. C. instrument and those of the regular unifilar magnetometer and dip circle, when the agreement was found satisfactory.

I am therefore of the opinion that a traveler furnished with a theodolite for land surveying purposes, but fitted with a reversible magnetic needle, can at any time he observes a true bearing obtain a trustworthy value of the declination. Dismounting the theodolite from his tripod, the latter will serve for mounting an L. C. instrument with which to observe the inclination and force. Thus, by adding to his ordinary equipment an instrument weighing in its box about 21 pounds, he can obtain valuable contributions to terrestrial magnetism, and at the same time give useful assistance to geological investigations.

CONCLUDING REMARKS.

Although a great subject like terrestrial magnetism, even to exhibit our present knowledge of the science, cannot be brought within the compass of an address—for it requires a treatise of many pages—I have brought some of the broad features of it before the Section in order to show its connection with Geography.

I also entertain the hope that geographers will become more interested in a subject so important to pure science and in its practical applications, and that it will become an additional subject to the instruction which travelers can now obtain under the auspices of the Royal Geographical Society in geology, botany, zoology, meteorology, and surveying.

There is a wide field open to observers, and where results often depend so much upon locality we require to explore more and more with the magnetic needle. To look over the great oceans and think how little is being done for terrestrial magnetism is a great matter for regret. Yet even there we may begin to be hopeful, for the United States Coast and Geodetic Survey authorities are making arrangements to fit out its vessels with the necessary instruments for determining the magnetic elements at sea.

We wish them all success; but I must again remind you that although we cannot compel observers to start, there is room for them and to spare.

I would fain make some remarks on the prevailing ignorance of sound geography in many quarters, and on the defective methods of teaching the science; but I feel that the subject is placed in very able hands, and will be fully discussed elsewhere during the present meeting.

THE AMHERST COLLEGE OBSERVATORY.*

By MARY PROCTOR.

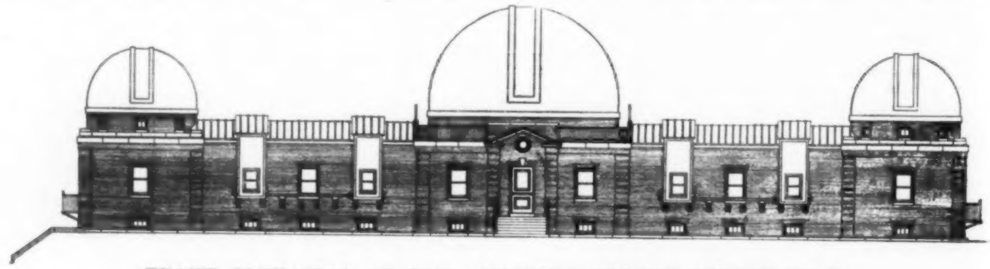
OUR illustrations show the plans of the new observatory, the cornerstone of which was laid on Wilder Hill, Amherst, Mass., one day during last June; President Harris, Mr. James, of New York, and ex-Governor Allen, of Porto Rico, officiated.

After the opening ceremonies Prof. Todd gave a brief sketch of the early history of astronomy at Amherst College, from the year 1825 to the present time. In October, 1900, the promise of $25,000 was made to Prof. Todd, for the construction and equipment of a new observatory, conditional upon his raising a like sum from other sources. For the completion of this fund, the department and the college are indebted to alumni and other friends of this institution, and at the commencement of 1901 the new observatory was assured.

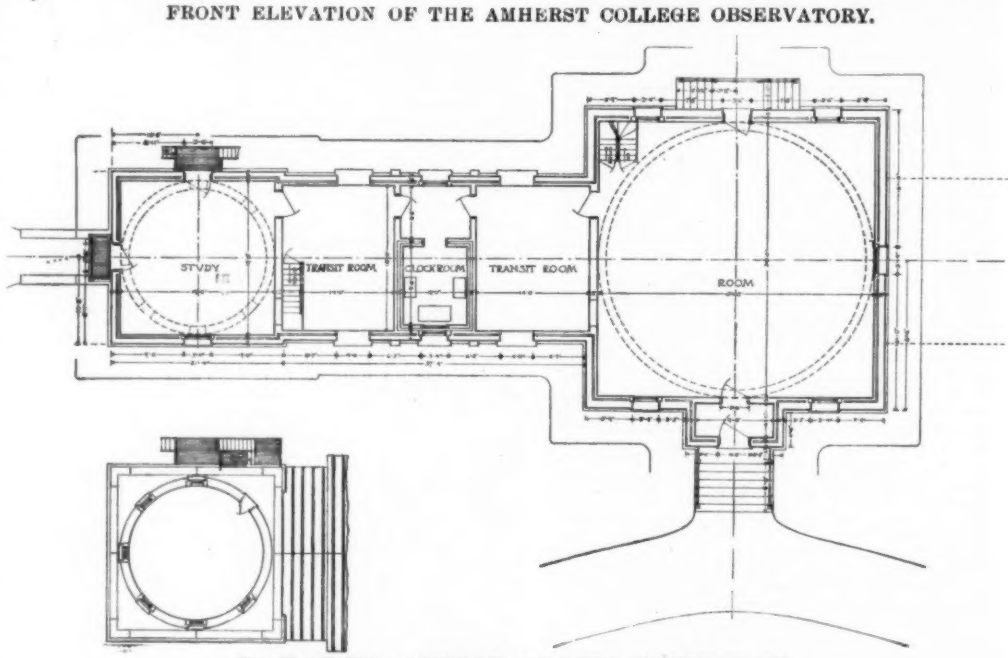
The title to the land on which the new building is located was acquired by gift of Mr. D. Willis James in January, 1903. This tract of about two acres makes a complete reservation of continuous college property (with the grove and both athletic fields), nearly forty acres in extent; and it may be considered as sufficient for future protection of observatory interests, especially as the horizon is open in every direction. The elevation above sea level is something in excess of 300 feet. The trustees appointed Mr. George A. Plimpton, Mr. D. Willis James, and Mr. G. Henry Whitcomb a committee on the observatory.

The completed plans for the observatory show a structure about 150 feet long, east and west, and surmounted by three domes, the central one of which is 33 feet in diameter. This will house an equatorial telescope with a glass 18 inches in diameter and 21 feet long. The Alvan Clark & Sons Corporation, of Cambridge, are already well advanced with the construction of this telescope, and have contracted to complete it in time for the commencement of 1904. In consequence of the present high cost of building operations, only the large dome and the eastern one of the two lesser domes (with the intervening room for transit instruments) will be built during the present season.

Following Prof. Todd's address, numerous letters of greeting were read from many well-known astronomers in the United States and other parts of the world. A number of college presidents also sent congratulatory letters, and others were received from Dean Robbins, of the General Theological Seminary, New York; Dr. Edward E. Hale, Col. Thomas Wentworth Higginson, and Mrs. Julia Ward Howe. These letters were deposited in a bronze box, sealed in the cornerstone, by Mr. G. A. Plimpton, chairman of the Observatory Committee, together with signed portraits of President Roosevelt and Governor Bates.



FRONT ELEVATION OF THE AMHERST COLLEGE OBSERVATORY.



PLAN OF THE AMHERST COLLEGE OBSERVATORY.

Mr. George A. Plimpton then pronounced the following old Latin blessing (1490): "Benedicte, Dominus, nos et ea quae sumus facturi; benedicat dextera Christi. In nomine Patris et Filii et Spiritus Sancti, amen." He then turned the first sod, after which the prayer offered by the Rev. Dr. Henry Preserved Smith concluded the exercises.

Subsequent to the ceremony of breaking ground on the hill, Mr. George W. Cable, of Northampton, planted a maple at the astronomer's dwelling, another welcome addition to the trees already christened by Mrs. Julia Ward Howe, Mrs. Alice Freeman Palmer, Dr. Edward Everett Hale, Col. Thomas Wentworth Higginson, and other guests during the past five years at Observatory House.

The following is an ode written for the occasion by Mrs. C. E. Whiton Stone:

They built a temple in the days of old,
When Solomon was ruler, bright
With carven pomegranates and with lilies white,
And cherubim, their wings alight
With magnitudes of gold!
Ye lay the cornerstone of one,
Sacred as that of Solomon,
From whose great dome ye can discern
The wheels of blazing chariots as they turn,
And stars and planets that unswerving ride,
Like cohorts of Jehovah, side by side,
Each as it rushes swift through space,
Held by eternal laws in place
But the gigantic fragment of a scheme,
Of whose magnificence ye scarcely dare to dream.

* Specially prepared for the SCIENTIFIC AMERICAN SUPPLEMENT.

Nor, though the centuries still hold it fair,
Can even the Parthenon compare
With this, undecked, ungemmed, uncarven, but consecrate
To study of the eternal heavens. Go, men of science, rate
Yourselves as puny, who have striven in vain,
The keys of all the million worlds to gain.
For what are ye? Puny, nought but specks, but specks that float and fly
Through golden cycles of infinity.
And yet, although ye know
Your human limitations, since ye also know ye are divine, go
And seek to track the trackless ether. Learn the ways
Of everlasting things, and fill your days
With vast discoveries
Till ye shall rise
Yea, circling upward, sun by sun,
To that sublime discovery, science and God are one.

For the use of the illustrations we are indebted to McKim, Mead & White, the architects.

ONE-WHEEL WATCH.

THIS watch was constructed by Gautrin, a watchmaker of Paris, and presented to the Institute about 1790. In 1894 it fell into the hands of M. Ed. Sordet, and was placed in the Museum of the Ecole d'Horlogerie of Geneva. The watch was in lamentable condition, but Prof. James of the Horological School studied its curious mechanism, and succeeded in restoring harmony to its organs, and putting it in running shape.

The three illustrations represent it in whole and in detail.

A large wheel of sixty teeth of ratchet shape occupies the center. This has a diameter of 33 mm. (1.29 inch). Its arbor carries two pinions, one of which of 15 leaves receives the motive force from a barrel, through the intervention of a fusee of 70 teeth. The other pinion, of 10 leaves, drives the dial mechanism, which is composed of a wheel of 30 teeth, carrying a pinion of 10 leaves, which actuates a wheel of 40 teeth, to which the hour hand is attached.

The function of the large wheel, the only wheel of the regular train, is fourfold.

In the first place it works a pallet *a* (Fig. 2) fixed to the upper part of a vertical arbor *A* (Fig. 1). This latter carries also an unlocking pallet, *b*, a small barrel whose collet turns with the arbor, and a double rack, *r* (Fig. 1) with very angular ratchet teeth superposed inversely on each other.

This arbor carries in its lower part (Fig. 3) a conical disk, *d*, and a second rack furnished with a counter weight, so that the arbor with all its accessories is in equilibrium.

The large wheel acts in the second place on a lever, *c*, designed to raise the arbor, that is, to move it in the direction of its length.

It impels also a small lever, *e* (Figs. 1 and 2), which moves another lever, *f*, carrying a bold conical disk, *g*, designed to cause the descent of the arbor.

It acts finally on a lever, *h*, serving to restore force to the large wheel at the moment when the action is slackening by the rising of the arbor.

The double rack is a portion of the virgule or pallet escapement, in fact the wheel acts on two virgules fixed opposite each other on the same arbor, which carries

The large wheel receives the motive force and transmits it to the arbor by means of the pallet, *a*. During this function the arbor is raised; the double rack acts therefore on the upper virgule, and it moves from left to right, as represented in the figure; it at the same time energizes the small spring. Arrived at the end of its course, and there being no more teeth, it escapes, and thus the lever, *c*, which keeps the arbor raised, meets the wide space between two teeth, falls into it, and no longer retains the arbor in its position. At the

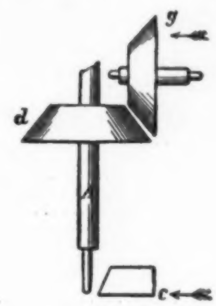


FIG. 3.

same instant, the gold disk, *g*, presses on the inclined plane disk, *d*, carried by the arbor, and forces it to descend. The rack arbor is therefore below; the large wheel has fallen at the same time on the locking lever, *i*, so that there is only the small spring which can furnish motive force in place of the chief motor; this comes into action, the virgule below being engaged with the lower rack, and the vibrations continuing, until, arrived at the end of its course, the lower rack escapes. At the same time the unlocking finger, *b*, has raised the beak, *i*, on which the large wheel is locked. The latter, being disengaged, falls on the large pallet, *a*; at the same time the lever, *c*, raises the arbor, and the upper rack is engaged with the virgule above. Then the series of functions is repeated in the same order.—Translated from the Journal Suisse d'Horlogerie.

FIG. 1.

a toothed semi-disk, *S* (Fig. 1), engaging with the balance staff, properly so called, *t*. It is not the balance which carries the spring, but the arbor of the virgules.

The small barrel is kept fixed by an outside hook connected with a Cardan joint, rendered necessary in consequence of the vertical displacement of the arbor.

A lever, *i*, forming a rest for the large wheel, works the lever, *f*, carrying the gold disk.

The mechanism acts in the following manner:

THE ENGINEERING STANDARDS COMMITTEE.

A SHORT review of the Engineering Standards Committee has been issued by the secretary, Mr. Leslie S. Robertson, who concludes that "the epitome sufficiently indicates the enormous importance of the work in hand to the trade of the empire. The Premier, Mr. Arnold Forster, Sir John Wolfe Barry, and others have expressed opinions as to the immense value of its labors, the result of which it is difficult to overrate if they are as loyally supported by the trade and commerce of this country as by the government and its various departments."

The movement was set on foot in the beginning of 1901, when the five leading technical institutions—civil engineers, mechanical engineers, naval architects, iron and steel institute, and electrical engineers—supplied funds and formed committees in order to introduce into this country a national standardized system, and thus bring British manufacturers into line with their American and German rivals. The work grew enormously, and the government, recognizing its national importance, made a grant of £3,000 ($14,600) toward the expenses, and now the leading manufacturers are also subscribing to the support of the Engineering Standards Committee. No fewer than 27 committees have been at work during the past three years, with 170 members, including 25 representatives of government departments, and the result of their labors so far is very satisfactory.

Referring to the committee on bridges and general building construction, presided over by Sir Benjamin Baker, the report says that their labors have been confined principally to drawing up a series of standards so as to meet all the requirements of general building construction, and they have succeeded in making a considerable reduction from the large number formerly in vogue, and some of the leading firms have already adopted them.

In the matter of tramway rails, the subcommittee have agreed upon a series of standards which have been approved by the Board of Trade and have even been rolled abroad, and the report of the subcommittee on railway rails is nearing completion.

The standardizing of electrical plants is presided over by Sir William Preece, and four subcommittees have been doing a lot of useful work. The subcommittee on generators, motors, and transformers have been collecting evidence for the determination of standard voltages and frequencies, and also the standard sizes for dynamos and motors. The other electrical committees deal with such subjects as cables and conduits, telegraphs and telephones, and the temperatures of insulating materials.

The Indian government appointed a conference to discuss the question of standard types of locomotives, and they have referred some of their findings to be dealt with by the Engineering Standards Committee and five committees have since dealt with the various branches of Indian locomotives and submitted a report to the Secretary of State for India, setting forth the types of locomotives which they think best adapted for Indian railways. It is anticipated that great advantages will be gained by the interchangeability of the different parts of locomotives, the object being to enable the British manufacturers to deal with the Indian orders and deliver the material more quickly, an advantage hitherto held by Americans and Germans through their system of standardization.

The work of the shipbuilding committee has been under the chairmanship of Mr. Archibald Denny, and their object has been to decide upon a series of sections which would give sufficient graduation and yet not be larger than could possibly be avoided, so as to reduce to a minimum the plant and stock of rolls to be kept by the steel makers. This committee has also been discussing the sizes of test pieces for iron and steel material used in the construction of ships and their machinery with the object of arriving at a common basis of agreement between the many divergent specifications and restrictions at present in vogue.

It may be mentioned that the French government have sent over a commissioner to study the procedure and the lines upon which the Engineering Standards Committee has been organized.—London Times.

PRACTICAL HINTS FOR MARKING BOTTLES WITH ETCHING-POWDER AND ETCHING-INK.

FOR the marking of smooth bottles, i. e., those not having their owner's name blown upon them, with any desired firm name or trade mark, many good-sized establishments make use of the sand-blast, and this means has proven most satisfactory, in its way.

Yet there are many smaller men putting up things in smooth bottles upon which they, too, would like to see their name or trade mark, and what is more, they would also like to know how to put it there at small expense.

For the benefit, then, of these less fortunate ones,

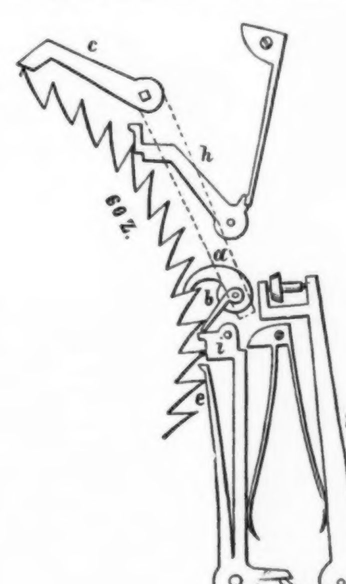


FIG. 2.

we take the liberty to present some hints upon the subject.

Two ways of marking the bottles are at our service: Dry etching and stamping with etching-ink. The first process is often followed in glass factories. For this work a rubber stamp is necessary, and it is advisable to have the letters as large and clean cut as possible; avoid crowding them together. The other requisite is the etching-powder, which may be procured from Schuster & Wilhelmy, in Görlitz, Germany.

Choose, if possible, a workroom where the temperature can be kept between 16 deg. and 20 deg. R. (68-77 deg. F.) and if practicable under a window, or flue, where the fumes can escape. Now take a small quantity of the dry etching-powder and place it in a porce-

lain dish upon a hot sand-bath or over a low flame and heat it until it is dust-dry and can be rubbed to the finest powder.

Now the glass bottles to be marked must be well cleansed and perfectly dry; slightly warm would be better, though this is not a necessity. With a sharply cut rubber stamp, over which a roller, supplied with thick oil, has been passed, print the required device lightly upon the bottle, and by means of a camel's-hair brush dust the warm dust-dry etching-powder upon it; any surplus powder may be removed with a fine hair brush (of course, we mean any powder not sticking to the oily device left by the rubber stamp). The bottle thus printed may now be put in a damp place for several minutes, and thereafter well washed in water. The dampness will have aided the corrosive powder to accomplish its work. Glass cylinders or large flasks, carboys, etc., may be handled in a slightly different way. Between two boards place the rubber stamp so that it shall project about ¼ mm. above their upper surface; prepare it as before and then roll the cylinders over it; arrived on the other side, it will be found to have taken off a good imprint of the device upon the stamp; the rest of the operation is the same as with the little bottles. Apply the etching-powder, set aside, and after a few minutes wash off.

Perhaps some of our readers may desire to perform the work in a less circumscribed manner. For those, the second procedure is available. Fluid glass-etching ink can be obtained from the same firm that supplies the corrosive powder, and they sell it in caoutchouc flasks. A few drops taken from the flask and spread evenly over a hard rubber plate will serve for a trial.

The rubber stamps used must, like the others, be as large and sharp as possible, and care must be taken to touch it only lightly to the ink, for if the letters spread they will make a bad job. Perhaps it would be better to work the hand in by a few trials upon some pieces of glass; it is easily done, and a few trials will suffice. With this ink one may also write upon the glass. It possesses another advantage, that this work may be accomplished with an ordinary steel pen. All dirt and grease must be removed from the bottles by washing them in water containing soda. The ink, too, must be well shaken before each dip of the pen. Immediately after the writing the bottle must be washed off. Close attention to the above instructions will produce bottles nicely and evenly marked, presenting the appearance of ground glass.—Neueste Erfindungen und Erfahrungen.

MISCELLANEOUS NOTES.

Several years ago the construction of a huge building was begun in England for the purpose of housing forty thousand Jews. It was called Jezreel's tower. The work was enthusiastically carried on until the walls had risen to the height of several stories. How many floors would have been required to accommodate all remains an interesting problem for mathematicians. Both the capital and enthusiasm necessary for the project eventually parted, and the great shell was left roofless and windowless. The storms have demolished large sections of the walls and the great structure is rapidly falling into decay.

We send Dakota seed to Russia, from which she raises wheat to compete with our product in the markets of the world, says Collier's Weekly. To plant, cultivate, reap, and harvest her crops, we send to Russia nearly one-half our total exports of agricultural machinery. This year we have already shipped some 80,000 tons of these implements to the land of the Czar. In former years all this passed through the ports of New York and Philadelphia, but a fractional increase in freight rates between the lakes and the East has diverted the trade to southern ports, while experiments are being made in direct shipments from Chicago by way of the lakes, the St. Lawrence River, and the Atlantic Ocean. The cotton plant first came to America from Asia; now the greater part of the Central Asian crop is grown from American cotton seed. American cultivators till the soil, which is watered by an American irrigation system. Yankee gins clean the fiber, American compounds press the cotton into bales wrapped with American bands, and finally the cotton finds its way to Moscow over a railroad built with American capital, and is turned into cloth by second-hand machinery from an American cotton factory, to compete abroad with American prints. Another regular article of export to Central Asia is the Ohio grapevine cutting. The vineyards of Central Asia are all offshoots from American vines, and the fruit is prized above all others in Russia proper for its delicacy and flavor. Twenty to thirty tons of American grapes to the acre is a common yield in Central Asia, and as the American vine is free from parasites, it is being introduced everywhere the world over, from South Africa to Northern China and Japan. We still export tobacco plants to Russian Asia, so that the Russian tobacco, grape, cotton, and wheat crops are all American, once removed. No Oriental fable is stranger than the accomplishments of the up-to-date Yankee drummer. In Bagdad, the home of Aladdin, he offers new American lamps that burn either Russian or Ohio oil, for the old battered bronze tallow burners of the Bagdad housewife; and as these time-worn Oriental lamps find a ready sale in New York, the enterprising drummer who introduced the American lamp to Bagdad was well repaid for his trouble. Now, however, American lamps are becoming a drug in the Bagdad market, and the supply of old lamps is rapidly giving out, as our lamp trade with Turkey increases. A Connecticut firm manufactures sacred scarabei for the Egyptian tourist trade. The little charms are carved and even chipped by machinery, colored in bulk to simulate age, and shipped in casks to the Moslem dealers at Cairo. The Arabian guides are the chief buyers, many of them being adepts at "salting" the sands at the base of the Pyramids or about the sacred temples, where they artfully discover these scarabei before the very eyes of the Yankee tourist, and sell him for an American dollar an article manufactured at a cost of less than a cent, perhaps within a stone's throw of his own home. For enterprise, it beats wooden nutmegs.

ENGINEERING NOTES.

A recent census taken, for the firm, shows that the Krupp works in Germany employ, in all, 41,013 persons, of whom 4,046 were classed as managers, clerks, bookkeepers, overseers, etc., and 36,967 as workmen. The total number of persons supported by these works, including employes, their wives, children, and other dependants, was 147,645. The average wages paid last year were 4.52 marks, or $1.08 per day.

On January 1, 1902, that is ten years after the introduction of the first two compound express locomotives on the Northern Railway of France, the seven most important French roads had, according to the Railroad Gazette, 1,128 compound locomotives in service, the classes being distributed as follows:

	Locomotives.
Four driving wheels not coupled, three cylinders	1
Four driving wheels not coupled, four cylinders	1
Four-coupled driving wheels, four cylinders	405
Six-coupled driving wheels, four cylinders	523
Six-coupled driving wheels, three cylinders	1
Six-coupled driving wheels, two cylinders	16
Eight-coupled driving wheels, four cylinders	181

A floating shears of 120 tons lifting capacity has recently been built for the Norfolk navy yard, for use in handling the heavy machinery, etc., of the new warships. The hull, which is of yellow pine sheathed with creosoted timber, is 133 feet long and 13 feet deep, with a double-story deckhouse containing the engines and boilers. The standing part of the shears or derrick consists of a steel A frame, with legs 87 feet long and 20 inches square. The legs rest in heavy shoes on the sides of the deck, and to the head is attached an inclined backstay or brace, 95 feet long and 12 inches by 15 inches section. Two triangular sets of horizontal braces connect the legs and backstay. The boom is 88 feet long, of rectangular section, 24 inches by 33 inches section at the middle, and having its heel fitted to a 7-inch pin in a shoe which revolves in a footstep bearing. The swinging engine has two cylinders, 9 inches by 10 inches. The hoisting engine has two cylinders, 10 inches by 12 inches, and two drums, 48 inches by 56 inches, with a gear reduction of 42 to 1 from the engine to the drum. The derrick has a working capacity of 120 tons at 20 feet clear from the side of the hull, and 60 tons at a distance of 40 feet. The speed of hoist is 5 feet per minute for all loads over 60 tons, and 10 feet per minute for loads of less than 60 tons. The cables are all of crucible steel. Steam is supplied by two vertical boilers, 7 feet diameter and 10 feet high.

The theoretical advantages of superheated steam have been fully realized for some time, but practical difficulties connected with its use in engines of the piston and cylinder type have so far debarred its general use. Notwithstanding all the efforts made to insure high steam economy during fully fifty years, there is at the present time no vessel of importance fitted with superheaters. A series of interesting trials upon a turbine of the De Laval type has recently been conducted at Dresden, and the results are embodied in a contribution to a German technical paper. The tests have continued during the past two years upon a 30-horsepower De Laval turbine in the laboratory with steam of 500 deg. C. superheat. The consumption of steam was accurately determined by condensing all the steam which passed through the turbine. Heat losses were provided against as fully as practicable by jacketing the apparatus. The turbine was arranged to be run at a speed of 20,000 revolutions per minute, reduced by gearing to 2,000 revolutions of the shaft upon which the brake was placed. The machine was operated by steam of a pressure of 6 kilogrammes per square centimeter (85.33 pounds per square inch), and when exhausting against the pressure of the atmosphere was rated to develop 30 horse power. An interesting feature of the tests is the use of various nozzles, experiments having been made with diverging and converging nozzles, using bronze and steel as materials. Broadly speaking, the results show a notable economy in steam consumption. The diverging nozzle gives better results than the converging type, and steel was found a more advantageous material than bronze.

Comparatively few experiments have hitherto been made upon wet and dry concrete, and owing to the lack of data on the subject a series of experiments was conducted this year by Mr. J. W. Sussex, at the University of Illinois. Forty-five 6-inch cubes were made with three percentages of water, and broken in a testing machine at the ages of seven days, one month, and three months. The quantities of water used were: For dry concrete, 6 per cent; for medium concrete, 7.8 per cent; and for wet concrete, 9.4 per cent; and the proportions of material adopted were 1 part cement, 3 parts sand, and 6 parts of broken stone. The dry concrete was about as moist as damp earth; the medium concrete would not quake in handling, but when well tamped water would flush to the surface; and the wet concrete quaked in handling, and would bear only slight tamping. From the published results of the tests in question we learn that at the age of three months or more wet concrete is stronger than either dry or medium concrete. When recently set, medium concrete gives the greatest strength, thus showing that wet concrete acquires its strength more slowly than drier mixtures. In breaking the cubes it was found that the wet concrete was distorted more than the dry before failure occurred, thus proving the existence of greater elasticity. By using a rather wet mixture a compact mass could be obtained with comparatively little tamping, whereas a compact mass could not be formed with any amount of tamping upon a dry mixture. Summing up the conclusions to be drawn from the experiments, it appears to be clear: 1, that dry concrete should not be used under any circumstances; 2, that medium concrete may be desirable in cases where immediate strength is required; and 3, that wet concrete is stronger than either dry or medium concrete at any age over three months.

TRADE NOTES AND RECIPES.

A short time ago H. Townley Sugden's office at Everley, Winchfield, Hants, on a brick field was invaded by ants, which caused much inconvenience. He soaked some paper with oil of peppermint and put it down, and also put some on the skirting where the ants came in. In half an hour there was not an ant to be seen. In a few days the odor of peppermint disappeared, but ants never returned. They have good memories.

New Paper and Wall Coating.—A new German composition for coating or impregnating pasteboard and similar material for roofing and other purposes, also applicable for coating the walls of buildings, etc., consists of a combination of resins and fats which are practically nonsaponifiable, such, for instance, as the cholesterin fats, the composition being applied in a molten condition or dissolved in a highly volatile liquid, such as benzine, turpentine, etc. Linseed oil, carnauba wax, and magnesium oxychloride are added to the mixture. In a recipe given, the following proportions are recommended: Sixty parts of colophony, 25 of neutral yolk, and 5 each of carnauba wax, linseed oil, and magnesium oxychloride. The material under treatment is immersed for about ten minutes in the fused composition and passed through heated rollers.

Welding of Spring Steel.—According to the Werkmeister Zeitung, the following is a very good method of welding, in cases where steel cannot be welded with sparkling head: Cast-steel filings or turnings of cast steel are dissolved in the smallest possible quantity of nitric acid, finely-powdered borax being added to the solution, which should be vigorously stirred, till a thin paste is formed. This paste is then again diluted with a little sal-ammoniac and kept in a bottle. When required for use, a thin coating of the solution is applied to the parts which are to be welded; the latter are then made red hot, and, when the mass has become fluid, lightly beaten with a flat hammer on an anvil in the same manner as hard solder. This process, however, can only be applied with advantage in cases of so-called "welding-on" (aufschweissen).

Automatic Feeding Apparatus for Boiler.—A feeding apparatus for boilers, the invention of Ferdinand Wegner, engine builder of Kamenskoe, has been protected by German patent No. 134,018. It belongs to the class of apparatus which is automatically set in action by a piston-valve or slide reversed by a float when the water falls below the normal level. It differs from similar contrivances known up to the present in this respect, that a single piston-valve is provided for opening and shutting off the steam as well as the feed water. A double float, held in a vertical position, serves to put the piston-valve in action. This float is provided with a buffer to secure the easy and safe action of the piston valve. The new apparatus has been thoroughly tested; it performs its duties with absolute accuracy, and renders the safety of the work entirely independent of the attention of the stoker.—Der Metallarbeiter.

Vessels for the Transport of Acids with a Protecting Lining of Asbestos.—For protecting the interior of vessels intended for the conveyance of acids, a lining of asbestos, made impermeable by means of wax, paraffine, etc., is employed. The barrel shape is the most suitable for these vessels, but they can be made in the form of bottles or boxes if desired. They consist of a cylindrical case of sheet iron, in which two edged iron end-plates are riveted. To facilitate the rolling of the cask, it is provided with two rings near the center. The iron case and rings are bent to the required diameter by a bending machine, the two iron end-plates turned back at the edges, and all holes necessary for riveting made. The sheet of asbestos for lining the cylindrical part of the cask is about 50 millimeters longer than the iron sheet. This additional length is wetted with water and bent back to an angle of 180 deg. Disks of asbestos, the diameters of which are about 80 millimeters longer than the greatest diameter of the cask, are used to cover the end-plates, and are likewise soaked in water and turned back at the border to a distance of 40 millimeters. The metal plug is provided with a coating of asbestos. For this purpose asbestos is mixed with water and kneaded till it forms a thin paste and can be put into any required shape. The lower portion of the plug, the portion exposed to the action of the acid, is coated with a layer of this paste and then put into a mold of corresponding shape in which the excess of water is pressed out. The asbestos parts are then thoroughly dried, and afterward plunged into a bath of boiling paraffine, stearine, or wax, where they remain till saturated. After half an hour they are taken out and allowed to dry and become cool. When the separate parts have been prepared in this manner, the construction of the cask is proceeded with. The lining of asbestos is put inside the metal case, and the two edges of the latter fastened together by a longitudinal seam. To avoid injuring the sheet of asbestos during the process of riveting, it is bent away from the iron side, an iron rim being inserted to serve as a support for the heads of the rivets. As soon as the riveting is completed, the rim is removed and the bent sheet of asbestos heated till the paraffine begins to melt, when it is pressed firmly against the interior of the vessel. Then the plug is inserted. When the cylindrical portion is finished, the coats of asbestos are put over the iron ends, and the latter with the coats riveted into the cylinder, the riveting being performed as usual from the outside. The whole interior of the vessel is now covered with asbestos, and protected from the action of the acids. A sufficient quantity of melted paraffine is now poured into the vessel, and the latter shaken and rolled in order that the paraffine may reach every part of the interior, thus filling up any joints or interstices. The plug may be made of glass or porcelain or of metal. It is fastened into the side of the vessel by means of a nut, through which rings of asbestos are pressed. To facilitate the replacing of the plug, it, as well as the opening in the vessel, is made of oval shape. If the plug is made of glass or porcelain, a screw stopper of the same material, with an asbestos ring affixed at the bottom, should be used.—Der Metallarbeiter.

TRADE SUGGESTIONS FROM UNITED STATES CONSULS.

Declining Meat Imports in Germany.—As was generally expected, there comes from the daily press throughout Germany complaints about the reduced supply of meat caused by the somewhat drastic meat inspection law, the last remaining clauses of which went into force on the 1st of April, 1903. The general effect of the new regulations will be inferred from the fact that during the three months from April 1 to June 30, 1903, only 3,250 tons of fresh meats were imported into Germany, against 4,715 tons during the same period of 1901 and 5,776 tons in 1902. The import of smoked and other simply prepared meats dropped from 6,561 tons to 2,240 and bacon from 3,073 tons to 771 during the April-June quarter, as compared with the imports for the same period of the preceding year. Hams declined likewise from 810 tons to 256 and other forms of pork meats from 1,825 tons to 574. Add to this the fact that by another clause of the same law, which has been in force since October, 1900, the importation of sausages and canned meats—of which 8,842 tons, valued at $2,046 800, were imported in 1899—has been prohibited, and it will be apparent that the German meat import has been reduced to about one-third of its former proportions. This in a nation of such liberal and constant meat eaters as the Germans is an economic fact of serious and far-reaching importance.

The deficit in imported meats has, however, been counterbalanced to some degre by an increase in the receipts of foreign cattle, of which there were imported during the first six months of 1903 174,000 head, valued at [illegible]4,000,000 marks ($12,852,000), as against 148,394 head, valued at 44,000,000 marks ($10,472,000), during the same period in 1902. This increased import of live cattle, however, is stimulated by another fact, viz., the new tariff law, which will probably go into effect some time next year. It raises the duty on imported cattle to [illegible]4.28 per 10 kilogrammes (220.4 pounds), live weight, which will all but prohibit importations under ordinary conditions of the market. Naturally such a change in duties has stimulated heavy importations during the last months before the new schedule is to go into effect.—Frank H. Mason, Consul-General at Berlin.

Foreign Commerce of Japan.—The foreign commerce of Japan has more than doubled in the last eight years. The commerce of 1902 was greater by $10,[illegible]90,000 than that of the preceding year.

The exports of 1902 show an increase of 2.3 per cent over those of 1901. When the injury inflicted on the three leading articles of export by the unseasonable spring weather is taken into account, the wonder is that there should have been any increase in exports.

The imports increased still more than the exports, which they exceeded in value by $6,687,240.45. This increase is due to the large amounts of tissues, yarns, threads, and raw materials therefor imported, and to increased purchases of grains and seeds, the importations of other articles being only a little greater or less than in the preceding year. Silk accounts for more than two-thirds of the whole increase in value of the exports, tea and tobacco being next.

Trade of the United States with Japan.—During each of the last five years the United States has purchased more of the products of Japan than any other country, and more than all Europe, yet British India and Great Britain each sell more to Japan than does the United States. However, the imports from the United States last year increased 13 per cent as compared with 1901, while those from most European countries fell off.

The United States continues to surpass all other countries in furnishing Japanese importations of electric light apparatus or instruments, electric motors, fire engines and pumps, flour, sole leather, kerosene oil, lubricating oil, paraffin wax, cardboard, leaf tobacco, timber other than teak, bicycles and tricycles, and electric light wire. Last year the United States took the lead, for the first time, in steam boilers and engines and telephones, but seems to be losing ground, as compared with other countries, in the importations of paper-making machinery, spinning machinery, weaving machinery, watches, iron nails, wire and small rod iron, telegraph wire, steel other than mild steel, and glazed or fancy paper.

Some articles which Japan imports in considerable quantities, and which the United States might compete more strongly in providing, are lifting machines, drilling and boring machines, turning lathes, machine tools, condensed milk, rails, fittings of rails, iron pipes and tubes, belting and hose for machinery, and railway freight and passenger cars.

The imports from Canada and other parts of British America to Japan now amount to only a trifle over 1 per cent of the value of those from the United States, but the people of the Dominion are making a strong effort to increase their trade in the East. At the Osaka Exposition, now open, the Canadians are spoken of as having the largest and best of the foreign exhibits. They are striving especially to advertise the merits of Canadian flour. Bread is baked on the grounds and sold or distributed freely among the natives, to whom the superior qualities of the Canadian product are explained, and it is reported that large orders have been received for flour as a result of this work. The United States has been furnishing from 96 to 99 per cent of all the flour imported into Japan, and last year this commodity ranked third in value of the imports from the United States, raw ginned cotton being first and kerosene oil second. The most important import from Canada in 1902 was salted salmon and trout, of which she furnished nearly twice as much as the United States, followed by timber and lumber—boards and planks—of which her quota was less than two-thirds of ours.

Almost one-third in value of all the exports of Japanese produce and manufactures was bought by the United States, whose purchase of silk alone amounted to more than the entire value of the Japanese imports therefrom and constituted nearly one-half the Japanese exports of silk. Silk in its various forms—raw, tissues, embroideries, etc.—accounts for eleven sixteenths of the Japanese exports to the United States; the next item in importance being tea, of which we took more than four-fifths of the whole export. Tea and silk make up four-fifths of the exports to the United States, the other one-fifth being divided among 150 articles, of which the most important are porcelain, straw plaits, camphor, floor matting, sulphur, tooth brushes, fans, and refined copper.

Trade with the Philippines.—The trade with the Philippine Islands has shown a declining tendency for some years. In 1902 the imports from that archipelago were less than in any other year of the last five, while the exports to the islands were less than in 1901. Sugar is the chief import into Japan from the Philippines, followed by flax, hemp, jute, and china grass. The exports to the Philippines cover a wide range, that of coal being of the greatest value, and potatoes second.

Trade with Hawaii.—The imports from Hawaii, although increasing, are still of little value, consisting chiefly of sugar. The exports to Hawaii include more than 130 different kinds of commodities, the most important being saki (a Japanese liquor resembling beer), rice, and soy (a condiment much used by the Japanese). An inspection of the items in the list of exports to Hawaii suggests the thought that this trade is principally due to the Japanese emigrants who have settled there.

Exports and Imports by Countries.—The value of the exports to and imports from the principal countries from and into Japan are shown in the following table:

Country.	Exports.	Imports.
China	$23,325,595.30	$20,214,247.43
British India	6 641,773.92	25,386,629.77
Hongkong	12,886.277.32	1,222,530.92
Korea	5,255,982.92	3,963,057.24
Russian Asia	1,068,190.79	2,970,001.11
Philippine Islands	862,406.00	743,944.83
Other Asiatic countries.	391,125.35	5,435,393.24
Great Britain	8,638,382.33	25,081,286.60
France	13,587,162.01	2,363,396.28
Germany	2,359,040.54	12,854,834.83
Other European countries	8,791,233.27	6,470,894.69
United States	39.955,936.97	24,229,106.81
British America	1,735,948.85	257,602.49
Hawaii	912,980.07	11,316.40
All other countries....	2.222,890.65	4,117,924.08
Total	$128,634,926.29	$135,322,166.72

Railways.—Soon after the Japan-China war, the Japanese government adopted several measures involving the expenditure of considerable sums in industrial enterprises which would require several years for their completion. Among these was a scheme for the expansion of State railway lines. Of 738 miles of railroad then projected 169 miles had been opened for traffic the first of April, 1902, and from the appropriation of $42,454,002 for this purpose $23,717,250 had been expended. The Diet was asked last winter to make a further appropriation of 55,000,000 yen ($27,499,900) for the construction of these roads, and this was granted; but it is claimed that the ministry have consented to introduce a bill into the Diet at its next session providing that future expenditures for railway construction shall be limited to the profits from lines already in operation. The total mileage of State railways on April 1, 1902, was 1,060, and the net profit for the previous year was $4,182,227.74, or a fraction over 8 per cent on the cost of construction. The total mileage of private roads at the same date was 2,967, and they report a profit of 8 per cent. The total passenger mileage on all roads for the year was 1,899,253,377 and the total goods ton mileage 791,106,994. There are 1,350 locomotives, 4,529 passenger cars, and 19,774 freight cars in use.

Street Railways and Automobiles.—The people of Japan have hitherto depended principally on the jinrikisha as a means of going about the cities, although electric street railways and horse-car lines exist in some places. An electric street tramway company was organized in Tokyo, the capital, several years ago, but owing to the insufficiency of funds no further progress was made. Lately, English capitalists have arranged to take half the shares of the company, which is thus enabled to proceed with its plans, and workmen have begun to set poles and stretch the wires for the street car lines. An automobile has been purchased by a silk firm for use in delivering goods, and promoters are endeavoring to establish a company for operating a passenger automobile service between Nagoya and Atsuta, two cities about 10 miles apart in the center of the porcelain manufacturing district, already connected by steam railway.

Government Shipbuilding and Steel Production.—For the purpose of rendering the country independent of foreign industry in all that pertains to the building and furnishing of ships, an iron industry was established at Wakamatsu, in the northern part of Kiushu Island, and although more than $10,000,000 has been expended where the original estimates called for only $2,000,000, and a committee of investigation appointed by the Japanese government has lately reported that the works cannot be expected to become self-supporting before the fiscal year 1907-8, there is no sign of faltering on the part of the government. The budget presented to the Diet at its last session contained an item of $1.000,000 as a supplementary fund for the Wakamatsu foundry, and this has been granted.

In spite of the fact that lower taxation was made at issue between the political parties, the government has lately engaged in the construction of another foundry at Kure, a port on the eastern coast of the main island.

It is computed that the Wakamatsu foundry will turn out 30,000 tons of manufactured iron during the fiscal year 1903-4, but that its value on the market will be only about two-thirds the working expenses of the foundry. Two iron mines and three coal mines within a radius of 20 miles of the works have been acquired for the use of the Wakamatsu works and have been connected therewith by railways. The works are designed to supply the steel materials required by the government departments, and will supply certain kinds of steel in large quantities to Japanese engaged in industry. Of the three battleships, three armored first-class cruisers, and three second-class cruisers now about to be added to the Japanese navy, it is reported that all except one battleship will be built in native yards. This will be the first experience of the native shipbuilders in constructing any warship of a class higher than cruisers, and there are not now facilities for manufacturing armor plate for such vessels; but the Kure foundry is expected to be able to provide plates of this kind after 1905.

Shipping.—The number and tonnage of merchant vessels, steam and sail, which entered Japanese ports during 1902 was greater than in any previous year. There is no marked change in the proportion belonging to different countries, though the increase, both in number and tonnage, of Japanese vessels was greater than in those from other countries.

Imports and Exports of Specie.—In spite of the excess of imports over exports of commodities, the imports of gold and silver specie and bullion exceeded the exports by $15.005,923.38. How much of this is due to the sale in London of the government bonds to the face value of $25,000,000, for which arrangements were made in October, it is not possible to determine, but it is significant that the excess in value of imports of commodities plus the excess of imports of specie and bullion is a little less than the value of the bonds.

Banks and Banking.—Interest rates have declined steadily throughout the year, and the banks report increased deposits due to inactivity in trade and industry.—E. C. Bellows, Consul-General at Yokohama.

American Machines and Tools in Roubaix.—American machinery and labor-saving tools are making headway in this great industrial district. American-made boots and shoes are to be seen in most of the large stores. In my last annual report I mentioned a shoe manufacturer of this district who had made a complete change in his establishment by putting in American machinery. His trade has so increased by the change that he will soon have to increase his plant.

American agricultural machinery, tools, etc., are now being used extensively and with great success, and our fruits and canned goods are sold in most of the stores, being generally preferred even to French goods of the same kind. There is a large field in this district for all kinds of American goods, such as machinery, tools, hardware, typewriters, desks, farming implements, stoves, motor cars, bicycles, dried and canned fruit, novelties, etc. The sales of these goods should be intrusted to general agents who understand the language and trade methods of the French. Printed advertising matter, unless in French, is absolutely useless here. Great attention should be paid to packing for export. Poor packing very often causes the loss of a good customer. Weights and measures should always be given in the weights and measures of the country for which the goods are intended. German imitations of American machinery are sold in this district as American machinery, and of course so much cheaper as to keep out the genuine articles.—W. P. Atwell, Consul at Roubaix.

Camphor Forest in Formosa.—A camphor forest of 50,000 acres, containing fully 120,000 trees, has been found on the island of Formosa.

Preferential Prices to Foreign Buyers.—The German Association for Commercial Treaties publishes a communication to its members in which it inveighs against the policy of the German trusts of selling their products to foreign consumers at slaughter prices while at the same time they exact high prices from domestic purchasers. The published statement of the above-mentioned association declares that in one of the adjoining foreign states quite a new line of trade has been established. It consists in large consignments of iron tubing and heavy cast iron products received from Germany at points close to the latter's border. These articles are sold at such a large discount below the ruling home rates that they can be resold and reshipped to Germany at a profit, although the German customs duties have to be paid on their entry into Germany. Where German consumers reside not very far from the foreign border they are enabled to import these heavy iron products, pay the return freight and the customs duties on same, and save from $40 to $62 per ton on the price they have to pay by ordering direct from the syndicate (trust) controlling the manufacture and sale of these iron products.—Simon W. Hanauer, Deputy Consul-General, Frankfort.

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SELECTED FORMULÆ.

Stencil Ink.—Boil together, shellac 2 ounces, borax 1½ ounces, and water 10 fl. ounces, until the solution measures half a pint; then incorporate a mixture of powdered lampblack or drop-black, and gum acacia, each 1 ounce.—Pharmaceutical Era.

Ink for Glass.—Dissolve 20 parts of resin in 150 parts of alcohol and add to this solution, drop by drop, and under continuous stirring, a solution of 35 parts of borax in 250 parts of water. Finally dissolve 1 part of methylene-blue in the mixture.—Pharmaceutical Era.

Roach Powder.—

Insect powder	1 pound
Powdered borax	5 pounds
Red precipitate	10 grains
Cudbear	10 grains
Carmine	10 grains

—Pharmaceutical Era.

Mahogany Stain for Wood.—Rub the surface of the wood with a solution of nitrous acid, and then apply, with a brush, the following:

Dragon's blood	1 ounce
Sodium carbonate	6 drachms
Alcohol	20 ounces

Filter just before use.

—Drug. Circ.

Kid Glove Cleaner.—

Soft soap	1 ounce
Water	4 ounces
Oil of lemon	½ drachm

Precipitated chalk, a sufficient quantity.

Dissolve the soap in the water, add the oil and make into a stiff paste with a sufficient quantity of chalk.

Rose Sachet.—

Orris root	200 parts
Rose leaves	600 parts
Sandalwood	100 parts
Patchouly	100 parts
Oil of rose geranium	3 parts
Oil of rose	2 parts

—Drug. Circ.

Cement for Metals.—

Litharge	2 parts
Boiled linseed oil	2 parts
White lead	1 part
Copal	1 part

Heat together until of a uniform consistence, and apply warm.—Drug. Circ.

Depilatory Powder.—

Barium sulphide	10 parts
Zinc oxide	5 parts
Wheat starch	5 parts

Triturate intimately to a fine powder. To be used as a depilatory by making a thick magma, which is allowed to remain for 10 minutes on the surface to which it is applied.—Pharmaceutical Era.

Mounting Paste.—

Gelatin	150 grains
Arrowroot	308 grains
Water	8 fl. ounces
Methylated spirit	2½ fl. drachms

Soak the gelatin for a few hours in 2 ounces of the water, then make a paste with the arrowroot and remaining 6 ounces of boiling water; mix, heat gently till dissolved, and as the mixture cools add the methylated spirit and solution of formaldehyde.—Pharm. Era.

Harness Wax.—

Oil of turpentine	900 parts
Yellow wax	90 parts
Prussian blue	10 parts
Indigo	5 parts
Bone black	50 parts

Dissolve the wax in the oil, by aid of low heat, in a water-bath. Mix the remaining ingredients, which must be well powdered, and work up with a portion of the solution of wax. Finally, add the mixture to the solution, and mix thoroughly in the bath. When a homogeneous liquid is obtained, pour into earthen boxes.—Pharm. Era.

Furniture Paste.—

Paraffin wax	7 ounces
Petroleum jelly	2 ounces
Solution of potassa	5 drachms
Yellow wax	3 ounces
Alkanet root	1 ounce
Turpentine	12 ounces

Place the first four ingredients in a vessel and melt with gentle heat, then add the others, digest an hour and strain.—Drug. Circ.

Aromatic Cachous.—

Oil of cinnamon	6 minims
Oil of peppermint	32 minims
Oil of neroli	12 minims
Cloves, freshly powdered	40 grains
Cardamoms, freshly powdered	80 grains
Vanilla, freshly powdered	120 grains
Orris root, freshly powdered	150 grains
Mace, freshly powdered	400 grains
Sugar	1 ounce
Powdered extract of liquorice	3 ounces

Water, a sufficient quantity.

—Drug. Circ.

Restoring Tarnished Gold.—

Sodium bicarbonate	20 ounces
Chlorinated lime	1 ounce
Common salt	1 ounce
Water	16 ounces

Mix well and apply with a soft brush. A very small quantity of the solution is sufficient for effecting the desired purpose, and it may be used either cold or lukewarm. Plain articles may be brightened equal to new by putting a spot or two of the liquid upon them from the stopper of the bottle and lightly brushing over the surface with fine tissue paper until sufficiently dried off to accomplish the object intended.—Pharmaceutical Era.

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